SilverMax™

Command Reference

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Table of Contents

SilverMax Command Set Overview 6
Command Structure 10
COMMAND NUMBERS 10
COMMAND PARAMETERS 10
SILVERMAX RESPONSE 10
Scaling 11
Filter Parameters 11
Position Parameters 11
Velocity Parameters 11
Acceleration Parameters 11
Time Parameters 12
Command Types 13
IMMEDIATE TYPE COMMANDS 13
PROGRAM BUFFER 13
PROGRAM TYPE COMMANDS 13
COMMAND CLASSIFICATIONS 14
Examples 15
SilverMax Commands – Detailed Description 16
STATUS COMMANDS 16
Clear Poll (CPL) 17
Poll (POL) 19
Read I/O States (RIO) 20
Read Internal Status Word (RIS) 21
Read Program Buffer (RPB) 22
Revision (RVN) 23
OVERRIDE COMMANDS 24
Halt (HLT) 25
Restart (RST) 26
Single Step Exit (SSE) 27
Single Step Program (SSP) 28
Stop (STP) 29
INITIALIZATION COMMANDS 30
ACK DELAY (ADL) 31
ANTI-HUNT CONSTANTS (AHC) 32
ANTI-HUNT DELAY (AHD) 33
ANTI-HUNT MODE (AHM) 34
BAUD RATE (BRT) 35
CALIBRATE ANALOG INPUT FROM NV (CAI) 36
CONTROL CONSTANTS (CTC) 37
DISABLE DONE BIT (DDB) 38
DIGITAL INPUT FILTER (DIF) 39
DIRECTION (DIR) 40
DUAL LOOP CONTROL (DLC) 41
DISABLE MOTOR DRIVER (DMD) 43
DISABLE MULTI-TASKING (DMT) 44
ENABLE DONE HIGH (EDH) 45
ENABLE DONE LOW (EDL) 46
ENABLE MOTOR DRIVER (EMD) 47
ENABLE MULTI-TASKING (EMT) 48
ERROR LIMITS (ERL) 50
FILTER CONSTANTS (FLC) 52
GRAVITY OFFSET CONSTANTS (GOC) 53
IDENTITY (IDT) 54

KILL DISABLE DRIVER (KDD) *55*
KILL ENABLE DRIVER (KED) *56*
KILL MOTOR CONDITIONS (KMC) *57*
KILL MOTOR RECOVERY (KMR) *59*
LOW VOLTAGE TRIP (LVT) *60*
MOTOR CONSTANTS (MCT) *61*
MAXIMUM TEMPERATURE TRIP (MTT) *62*
OPEN LOOP PHASE (OLP) *63*
OVER VOLTAGE TRIP (OVT) *64*
PHASE ADVANCE CONSTANTS (PAC) *65*
POWER LOW RECOVERY (PLR) *66*
PROTOCOL (PRO) *67*
S-CURVE FACTOR (SCF) *68*
SELECT EXTERNAL ENCODER (SEE) *69*
SERIAL INTERFACE (SIF) *70*
SINGLE LOOP CONTROL (SLC) *71*
SOFT STOP LIMITS (SSL) *72*
TORQUE LIMITS (TQL) *73*
TORQUE RAMP UP (TRU) *75*
MODE COMMANDS 76
GO CLOSED LOOP (GCL) *77*
GO OPEN LOOP (GOL) *78*
POSITION INPUT MODE (PIM) *79*
REGISTERED STEP & DIRECTION (RSD) *80*
SCALED STEP & DIRECTION (SSD) *81*
TORQUE INPUT MODE (TIM) *83*
VELOCITY INPUT MODE (VIM) *84*
INPUT MODE USAGE (IMU) *85*
VELOCITY MODE, IMMEDIATE TYPE (VMI) *87*
VELOCITY MODE, PROGRAM TYPE (VMP) *88*
MOTION & PROFILE MOVE COMMANDS 89
MOTION & PROFILE MOVE COMMANDS 90
HARD STOP MOVE (HSM) *91*
INTERPOLATED MOVE START (IMS) *92*
INTERPOLATED MOVE QUEUE CLEAR (IMQ) *94*
INTERPOLATED MOVE WRITE QUEUE (IMW) *95*
MOVE ABSOLUTE, TIME BASED (MAT) *97*
MOVE ABSOLUTE, VELOCITY BASED (MAV) *99*
MOVE RELATIVE, TIME BASED (MRT) *101*
MOVE RELATIVE, VELOCITY BASED (MRV) *103*
PRE-CALCULATED GO (PCG) *105*
PRE-CALCULATE MOVE (PCM) *106*
PROFILE MOVE CONTINUOUS (PMC) *107*
PROFILE MOVE OVERRIDE (PMO) *109*
PROFILE MOVE (PMV) *110*
PROFILE MOVE EXIT (PMX) *111*
REGISTER MOVE ABSOLUTE, TIME BASED (RAT) *112*
REGISTER MOVE ABSOLUTE, VELOCITY BASED (RAV) *113*
REGISTER MOVE RELATIVE, TIME BASED (RRT) *114*
REGISTER MOVE RELATIVE, VELOCITY BASED (RRV) *115*
EXTENDED REGISTER MOVE ABSOLUTE, TIME BASED (XAT) *116*
EXTENDED REGISTER MOVE ABSOLUTE, VELOCITY BASED (XAV) *117*
EXTENDED REGISTER MOVE RELATIVE, TIME BASED (XRT) *118*
EXTENDED REGISTER MOVE RELATIVE, VELOCITY BASED (XRV) *119*
PROGRAM FLOW COMMANDS 120
CALCULATION (CLC) *121*

CLEAR PROGRAM (CLP) *124*
DELAY (DLY) *125*
END PROGRAM (END) *126*
JUMP ON INPUTS, AND-ED (JAN) *127*
JUMP ON INPUTS, NAND-ED (JNA) *128*
JUMP ON INPUTS, OR-ED (JOR) *129*
JUMP (JMP) *130*
JUMP ON INPUT (JOI) *132*
JUMP ON REGISTER EQUAL (JRE) *134*
LOAD PROGRAM (LPR) *135*
LOAD AND RUN PROGRAM (LRP) *136*
PROGRAM CALL (PCL) *137*
PROGRAM CALL ON INPUT (PCI) *138*
PROGRAM RETURN (PRT) *139*
PROGRAM RETURN ON INPUT (PRI) *140*
RUN PROGRAM (RUN) *141*
START DOWNLOAD (SDL) *142*
STORE PROGRAM (SPR) *143*
WAIT ON BIT EDGE (WBE) *144*
WAIT ON BIT STATE (WBS) *145*
WAIT DELAY (WDL) *146*
I/O COMMANDS 147
ANALOG CONTINUOUS READ (ACR) *148*
ANALOG READ INPUT (ARI) *150*
CONFIGURE I/O (CIO) *152*
CLEAR OUTPUT BIT (COB) *153*
DISABLE ENCODER MONITOR (DEM) *154*
ENABLE ENCODER MONITOR (EEM) *155*
MODULO CLEAR (MDC) *156*
MODULO SET (MDS) *157*
MODULO TRIGGER (MDT) *158*
POSITION COMPARE (PCP) *159*
SET OUTPUT BIT (SOB) *160*
DATA REGISTER COMMANDS 162
ADD TO REGISTER (ATR) *164*
REGISTER LOAD MULTIPLE (RLM) *165*
REGISTER LOAD NON-VOLATILE (RLN) *167*
READ REGISTER (RRG) *168*
REGISTER STORE MULTIPLE (RSM) *169*
REGISTER STORE NON-VOLATILE (RSN) *171*
WRITE REGISTER, IMMEDIATE TYPE (WRI) *172*
WRITE REGISTER, PROGRAM TYPE (WRP) *173*
WRITE CMD LONG WORD (WCL) *174*
WRITE CMD WORD (WCW) *175*
MISC. COMMANDS 176
CLEAR MAX ERROR (CME) *177*
CLEAR INTERNAL STATUS (CIS) *178*
CHECK INTERNAL STATUS (CKS) *179*
TARGET TO POSITION (TTP) *180*
ZERO TARGET (ZTG) *181*
ZERO TARGET & POSITION (ZTP) *182*
Summary of SilverMax Commands: **183**
STATUS COMMANDS 183
OVERRIDE COMMANDS 184
INITIALIZATION COMMANDS 185
MODE COMMANDS 194

MOTION & PROFILE MOVE COMMANDS 196
PROGRAM CONDITIONAL & FLOW COMMANDS 203
I/O COMMANDS 207
DATA REGISTER COMMANDS 209
MISC. COMMANDS 211
SilverMax Command Set - Numeric/TLA List 212
SilverMax Command Name Cross Reference Table 216
Index 222

SILVERMAX COMMAND SET OVERVIEW

Status Commands are used to retrieve information from SilverMax. These commands can all be used while SilverMax is executing a motion.

"**TLA**" = Three Letter Acronym

TLA	Status Commands
CPL	Clear Poll
POL	Poll
RIO	Read I/O States
RIS	Read Internal Status Word
RPB	Read Program Buffer
RVN	Revision

TLA	Override Commands
HLT	Halt
RST	Restart
SSE	Single Step Exit
SSP	Single Step Program
STP	Stop

Override Commands can Halt, Restart or Stop the SilverMax at any time. These override any current operation for greater control of the motor. Program execution can also be controlled.

Initialization Commands setup the SilverMax operating characteristics.

Typically these commands are placed in the "Initialization" program but may also be used during normal operation

TLA	Initialization Commands
ADL	ACK Delay
AHC	Anti-Hunt Constants
AHD	Anti-Hunt Delay
AHM	Anti-Hunt Mode
BRT	Baud Rate
CAI	Calibrate Analog Inputs from NV
CTC	Control Constants
DDB	Disable Done Bit
DIF	Digital Input Filter
DIR	Direction
DLC	Dual Loop Control
DMD	Disable Motor Driver
DMT	Disable Multi-Task
EDH	Enable Done High
EDL	Enable Done Low
EMD	Enable Motor Driver
EMT	Enable Multi-Task
ERL	Error Limits
FLC	Filter Constants
GOC	Gravity Offset Constant
IDT	Identity
KDD	Kill Disable Drivers
KED	Kill Enable Drivers
KMC	Kill Motor Conditions
KMR	Kill Motor Recovery
LVT	Low Voltage Trip
MCT	Motor Constants
MTT	Maximum Temperature Trip
OLP	Open Loop Phase
OVT	Over Voltage Trip
PAC	Phase Advance Constants
PLR	Power Low Recovery
PRO	Protocol
SCF	S-Curve Factor
SEE	Select External Encoder
SIF	Serial Interface
SLC	Single Loop Control
SSL	Soft Stop Limits
TQL	Torque Limits
TRU	Torque Ramp Up

TLA	Mode Commands
GCL	Go Closed Loop
GOP	Go Open Loop
PIM	Position Input Mode(Actually Target input)
RSD	Registered Step And Direction
SSD	Scaled Step And Direction
TIM	Torque Input Mode
VIM	Velocity Input Mode
VMI	Velocity Mode, Immediate Type
VMP	Velocity Mode, Program Type

Mode Commands put SilverMax into required and special modes of operation. Some modes give SilverMax the ability to input analog or Step and Direction signals for motion control.

Motion Commands give SilverMax the ability to follow a profile. All motion commands will accelerate using S-curve or linear ramps. SilverMax has a unique ability to do motion profiles using **"Time"** for the acceleration and velocity parameters.

TLA	Motion Commands
HSM	Hard Stop Move
IMS	Interpolated Move Start
IMQ	Interpolated Move Queue Clear
IMW	Interpolated Move Write to Queue
MAT	Move Absolute, Time Based
MAV	Move Absolute, Velocity Based
MRT	Move Relative, Time Based
MRV	Move Relative, Velocity Based
PCG	Pre-Calculated Go
PCM	Pre-Calculate Move
PMC	Profile Move Continuous
PMO	Profile Move Override
PMV	Profile Move
PMX	Profile Move Exit
RAT	Register Move Absolute, Time Based
RAV	Register Move Absolute, Velocity Based
RRT	Register Move Relative, Time Based
RRV	Register Move Relative, Velocity Based
XAT	Extended Register Move Absolute, Time Based
XAV	Extended Register Move Absolute, Velocity Based
XRT	Extended Register Move Relative, Time Based
XRV	Extended Register Move Relative, Velocity Based

Program Flow Commands are at the heart of SilverMax stand-alone operation. Complex programs can be created that provide a total motion control solution without need for an external “host” controller.

Programs can use I/O, Analog inputs, or the serial link for conditional operation. In many cases this ability eliminates the need for a PLC in the system.

TLA	Program Flow Commands
CLC	Calculation
CLP	Clear Program
DLY	Delay
END	End Program
JAN	Jump on Inputs, And-ed
JNA	Jump on Inputs, NAND-ed
JOR	Jump on Inputs, Or-ed
JMP	Jump
JOI	Jump on Input
JRE	Jump Register Equal
LPR	Load Program
LRP	Load and Run Program
PCL	Program Call
PCI	Program Call on Input
PRT	Program Return
PRI	Program Return on Input
RUN	Run Program
SDL	Start Download
SPR	Store Program
WBE	Wait on Bit Edge
WBS	Wait on Bit State
WDL	Wait Delay

TLA	I/O Commands
ACR	Analog Continuous Read
ARI	Analog Read Input
CIO	Configure I/O
COB	Clear Output Bit
DEM	Disable Encoder Monitor
EEM	Enable Encoder Monitor
MDC	Modulo Clear
MDS	Modulo Set
MDT	Modulo Trigger
PCP	Position Compare
SOB	Set Output Bit

I/O Commands provide SilverMax PLC-like qualities with 7 fully programmable I/O lines. Special I/O modes provide “Electronic Gearing” and other external control capability. Analog commands set up analog data input into SilverMax. Analog data can then be used by other commands and modes for analog operations.

Data Register Commands allow data management inside the SilverMax. Data can be stored into and loaded from Non-volatile memory to save calibration, offset or other data values. Several SilverMax commands can use Data Registers as parameters.

TLA	Data Register Commands
ATR	Add to Register
RLM	Register Load Multiple
RLN	Register Load from Non-Volatile
RRG	Read Register
RSM	Register Store Multiple
RSN	Register Store to Non-Volatile
WCL	Write Command Buffer Longword
WCW	Write Command Buffer Word
WRI	Write Register, Immediate Type
WRP	Write Register, Program Type

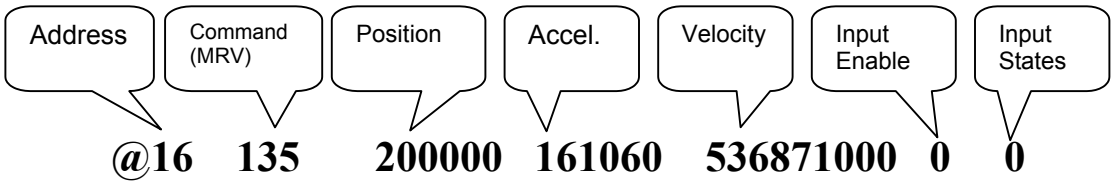
TLA	Miscellaneous Function Commands
CME	Clear Max Error
CIS	Clear Internal Status
CKS	Check Internal Status
TTP	Set Target to Position
ZTG	Zero Target
ZTP	Zero Target and Position

Miscellaneous Function Commands wrap up some of those nice but "ungroupable" commands. Most useful are the Zero, Target and Position commands that let the system set or clear its current position.

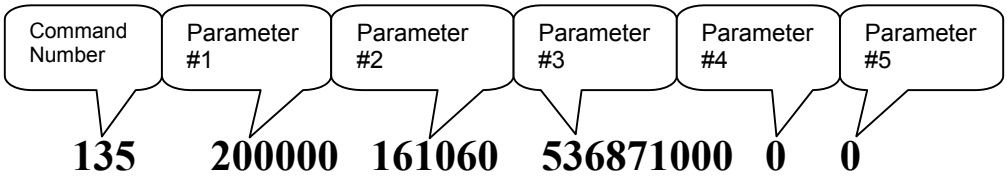
COMMAND STRUCTURE

SilverMax commands are setup with a simple structure that combines a command number with a set of parameters. Commands may have from 0 to 8 parameters depending on the command itself. If a command has a set of parameters, the parameters must be sent with the command even if they are not used.

The following is an example of the ASCII string of a motion command using the QuickSilver 8-Bit ASCII protocol.



This string breaks down into a command as follows:



Commands are organized into "Command Numbers" and "Parameters". Each SilverMax command has a defined set of parameters. Each parameter is separated by a single space character. In some cases, commands may not have any parameters.

Command Numbers

- Command numbers range from 0 to 255.
- Commands with numbers less than 64 are Host level **Immediate Type** only commands (See **Command Types** below for more details).
- Command numbers 64 or greater are commands that can be contained in a program.
- Commands with numbers 64 or greater will generate a "Busy" "NAK" code if sent to the motor while it is executing a command or a program.

Command Parameters

- Parameters that are **32-Bit** "Signed" can range in value from -2147483648 to +2147483647. "Unsigned" can range in value from 0 to 4294967295.
- Parameters that are **16-Bit** "Signed" can range in value from -32768 to +32767. "Unsigned" can range in value from 0 to 65535.
- Parameters must always be included in the command string even if the value is "0".
- Parameters that represent a "Bit" state are "1" for logic high (+5 volts on input) and "0" for logic low (0 volts on input).
- Parameters that represent a "Binary Word" must be converted to a number.
- < *parameter* > denotes 16-Bit numbers, << *parameter* >> denotes 32-Bit numbers.

SilverMax Response

SilverMax will respond to a command in one of three different ways:

- **Acknowledge (ACK)**. This is typical for most commands and is the simplest response.
- **Negative Acknowledge (NAK).** Something is wrong with the command or transmission.
- **Specific Data**. SilverMax information or Data that is requested by the command.

SCALING

Native SilverMax units are designed to take advantage of the entire parameter range whether it is 32 bit or 16 bit. Because of this, converting from engineering units to Native SilverMax units requires some scaling. The following sections describe scaling for the most popular command parameters.

Filter Parameters

The filter constants are calculated as follows:

Fv	Filter Value (Native SilverMax Units)
F	Filter in Hz (Cutoff Frequency – 3dB down point)
T	Time Sample (120 microseconds)
Fvl	Filter Value Limit (32768)

$Fv = Fvl\ e^{-F2\pi T}$

$F = -\ln(Fv/Fvl)/(2\pi T)$

Example: Position Input Mode (PIM) command with a 117Hz filter. The native SilverMax Filter Value is 30000.

$30000 = 32768\ e^{-(117)2\pi(120uS)}$

Position Parameters

The **Position Value Units** is in Encoder Counts. For a SilverMax with an encoder that provides 4000 counts per revolution, one revolution of the motor is 4000 counts. To scale a move to revolutions, multiply the revolutions value by 4000.

Velocity Parameters

The **Velocity** parameter is scaled internally as SilverMax velocity units. SilverMax velocity units are based on the maximum velocity value "2,147,483,647" being equal to 4000 RPM. This yields the number 536,871 as equal to one RPM.

To calculate **Velocity** in RPM, multiply the RPM value by 536,871.

Example: 200 RPM = 200 * 536,871 SVU = 107374200

Acceleration Parameters

The **Acceleration** value is scaled internally for SilverMax acceleration units. SilverMax acceleration units are based on the maximum acceleration value "1,073,741,823" being equal to 2000 RPM in 1 servo cycle (0.00012 sec.). This yields the number 64.4245 as equal to one RPM/sec. Or the number 3865.47 as equal to one RPS/sec.

To calculate **Acceleration** in RPM/sec, multiply the RPM/sec value by 64.4245.

Example: 10000 RPM/sec = 10000 * 64.4245 (1/RPM/sec) = 644245

To calculate **Acceleration** in RPS/sec, multiply the RPS/sec value by 3865.47.

Example: 166.7 RPS/sec = 166 * 3865.47(1/RPM/sec) = 644373 (Almost the same as above)

Time Parameters

The Native SilverMax unit for time is a “Tick” which is one clock cycle at 8KHz or 120 microseconds. To convert Ticks to seconds multiply by 0.00012. There are 8333 Ticks in one second.

COMMAND TYPES

The SilverMax command structure is divided into two major classifications: Immediate Type Commands and Program Type Commands. The Immediate Type Commands may only be executed via the serial link, while Program Type Commands may be executed via the serial link or from the non-volatile memory. Program Type Commands are temporarily stored in the **Program Buffer** prior to execution. Before executing a Program, the **Program Buffer** is filled with the given Program from either the serial communications or the non-volatile memory.

Immediate Type Commands

Immediate Type Commands typically give an immediate result or return data when executed. Most of these commands can be executed at any time even during SilverMax operation. Some Immediate Type Commands cannot be executed simultaneous to Program Buffer operations. These commands and the conditions for execution are noted in the command description. If command execution is attempted when not appropriate, SilverMax will produce a **NAK Busy** response.

Immediate Type commands do not use the **Program Buffer**. They are executed as soon as they are received.

Immediate Type commands can only be used via the serial communications interface, **they cannot be used within a Program that is downloaded to SilverMax for Program execution**. A "Host" controller may use Immediate Type Commands to set up, control or maintain status of a SilverMax.

Program Buffer

Program Type Commands are executed out of the Program Buffer. When a command is received through the serial communications, it is placed into the Program Buffer prior to execution. Because the buffer can store more than one unexecuted command at a time, SilverMax is able to execute commands sequentially in the form of a Program. Executing a Program allows for very accurate timing of complex motions. A Program that has been stored in the Non-Volatile Memory must be loaded into the Program Buffer before it can be executed.

Program Type Commands

Program Type Commands can be executed either from the serial communications interface or from non-volatile memory. Program Type Commands, as the name implies, can be part of a Program. When these commands are sent, they are first loaded into the Program Buffer, and then executed. This requires that the buffer not be in use at the time the command is sent. For example, they cannot be executed while the **Load Program** or **Store Program** commands are active. If a Program Type Command is sent while the motor is active, a **NAK Busy** response is returned.

Program Type Commands can also be downloaded to the Program Buffer without being executed. Once a Program has been assembled, it can either be executed immediately or it can be written to the Non-Volatile Memory. Programs can also be loaded from the Non-Volatile Memory and executed. In fact the SilverMax factory initialization is a Program which starts at location "0" in the Non-Volatile Memory and is automatically executed at the application of power.

Command Classifications

The SilverMax command set has been broken into the following classifications. Each class of command has a set of rules that define how or when a command can be used.

NOTE: "executed" for this section means to "Send a command real-time from a Host controller to SilverMax using the serial communications interface"

Class "A" Commands:

These are serial communications interface only. They may not be contained within a Program and their execution does not incidentally affect the Program Buffer contents. They may be executed at any time.

Class "B" Commands:

These are serial communications interface only. They may not be contained within a Program, but their execution affects the Program Buffer. They may be executed only while the motor is idle (No Motion or Program is running).

Multi-Tasking allows these commands to be executed at any time providing the conditions are appropriate. For example: the "**Start Download**" command should not be executed when a Program is running or when already in **Download mode**.

Class "C" Commands:

These are serial communications interface only. They may not be contained within a Program, but their execution affects the Program Buffer. They may be executed only while the motor is idle (No Motion or Program is running). The Program Buffer must also be loaded prior to execution.

Multi-Tasking – Allows these commands to be executed when a Motion is running but not when a Program is running.

Class "D" Commands:

These commands can be executed from the serial communications interface or as part of a Program. Their execution from the "Host" affects the Program Buffer. They may only be executed when the motor is idle. They are then stored to the buffer when in download (**Program Download**) mode. All of these commands have a command code of 64 (hex 0x40) or higher.

Multi-Tasking – Allows these commands can be executed when a Motion is running but not when a Program is running. Most commands will execute immediately while the "**Motion**" or "**Profile Move**" commands will be buffered until the current Motion is complete.

Class "E" Commands:

These commands are executed as part of a Program. They may be executed from the serial communications interface but should only be used within a Program or the motor operation may not be what is expected. They rely on what has been previously loaded to the Program buffer for operation. They can only be executed when the motor is idle. They will be stored to the buffer when in download (**Program Download**) mode. All of these commands have a command code of 64 (hex 0x40) or higher.

Multi-Tasking – Allows these commands to be executed while a Motion is running, but operation may not be what is expected as these are typically contained in a Program.

Class "F" Commands:

These are serial communications interface only. They may not be contained within a Program, but their execution affects the Program Buffer. They may be executed while the motor is running or idle.

EXAMPLES

All examples are given in the ASCII 8 bit protocol.

SILVERMAX COMMANDS – DETAILED DESCRIPTION

Status Commands

Status commands are used to retrieve information from SilverMax. These commands can all be used while SilverMax is executing a motion or a Program.

Clear Poll (CPL)

Description:

This is a complement to the **Poll** command. This command is used to clear the **Polling Status Word** bits (See Polling Status Word below). When a status bit is set ("1") it will remain set until a **Clear Poll** command is sent with the same bit set in its **Clear Status Word**. For example, if a Poll command gets back a **Polling Status Word** of "0x2000", bit 13 set (Program completed), of the **Polling Status Word** is set. To reset bit 13, the **Clear Status Word** must be set to "0x2000". This will cause bit 13 to be re-set ("0"). All other bits in the **Polling Status Word** will be left unchanged if the corresponding clear bit is not set. New occurrences since the last poll will NOT be cleared (the Status word is double buffered).

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Clear Poll (CPL)	Immediate (Class "A")	1 (0x1)	< Clear Status Word >	0 to 65535 (0 to 0xFFFF)

Example:

Clear only Bit #13 set in the Polling Status Word
Decimal 8192 = 0x2000 in Hexadecimal

@16 1 8192 (CR)

Clear all the bits set in the Polling Status Word

@16 1 65535 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

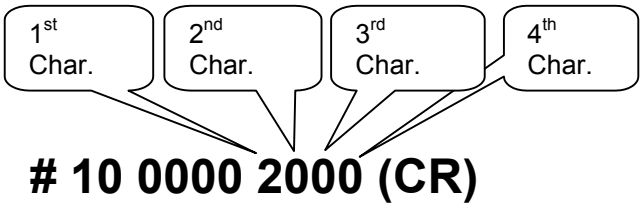
ACK only

Response Example:

*** 10 (CR)**

The **Poll** command has two types of responses: an Acknowledge, which indicates that there is no status to send, and a data packet, which contains the **Polling Status Word** in ASCII Hexadecimal format. The **Polling Status Word** is sent in 4 hexadecimal characters (0 – F). The first character is the upper nibble and contains bits 15-12. The second character contains bits 11-8. The third character contains bit 7-4. The final character is the lower nibble and contains bits 3-0. Each bit represents a current or past condition of the SilverMax device that was polled. If a bit is set ("1") this indicates the condition has occurred. Using the **Clear Poll** command individual bits can be cleared ("0").

Example: (8-Bit ASCII Protocol)



NOTE: For more information on the SilverMax **8-Bit ASCII protocol** see the "**SilverMax User Manual**"

Table Showing Data going from a Hexadecimal word to a Binary word

Hexadecimal Word	**2000**															
Nibbles	**2**				**0**				**0**				**0**			
Bit Values (For reference)	*8*	*4*	***2***	*1*	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*
Bit # (for reference)	*15*	*14*	***13***	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Binary Word	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0

Table with definitions of Status bits

Returned Character	Bit #	Definition
1st character	Bit 15	Foreground Command Done
	Bit 14	Foreground Command Error
	Bit 13	Command or Program complete
	Bit 12	Program errors
2nd character	Bit 11	Move terminated with sensor found
	Bit 10	Low/Over Voltage
	Bit 9	Position Error (Stopped)
	Bit 8	Motion Error (Moving)
3rd character	Bit 7	Receiver overflow
	Bit 6	Check Bit return Status (if condition found)
	Bit 5	Too long of message
	Bit 4	Framing Error
4th character	Bit 3	Motor shut down (Kill Motor Condition)
	Bit 2	Soft/Hard Limit
	Bit 1	Checksum error
	Bit 0	Aborted packet - data errors or new address frame

Poll (POL)

Description:

This command is used to determine the condition of a SilverMax unit. A **Poll** command can be executed at any time, including while SilverMax is in motion. Executing this command will cause the addressed SilverMax unit to return either an **ACK** (if no bits of the status are set), or the **Polling Status Word**. The **Polling Status Word** contains information about the current state of the SilverMax (See **Polling Status Word** Section in the SilverMax User Manual). The **Poll** command can be used when checking to see if a motion has completed. This is useful when a system must wait for a SilverMax to complete its operation before performing the next operation. It may also be used to verify that the last motion completed without any motion or position errors when the **ERROR LIMIT** command has been used to set up motion error conditions. The **Polling Status Word** bits are "Set" when the particular condition takes place. The bits are "re-set" using a **Clear Poll** command (See **Clear Poll** command above). Note: Additional conditions that occur after a **Poll** will show up in the following **Poll** even if those bits have been cleared in an intervening **Clear Poll** command. (i.e. they cannot be cleared until they have been read - the data is double buffered.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Poll (POL)	Immediate (Class "A")	0 or NONE (0x0)	NONE	NONE

Example:

Poll without command number

@16 (CR)

Poll with command number

@16 0 (CR)

SilverMax Response:

ACK only or Pulling Status Word 0 to 65535 (0000 to FFFF)

Response Example:

This is the SilverMax response with status – Indicates Command/Program Complete.
 # 10 0000 2000 (CR)

*** 10 (CR)**

QuickControl Example:

Immediate (Host) Mode Command Only

Read I/O States (RIO)

Description:

The **I/O State Word** is available for reading back the states of miscellaneous I/O conditions. This word may need to be read if more information on the motor status is required. For example: The upper I/O lines #4 to #7 may need to be read by a "Host". This word is dynamic and may change every servo cycle (120 usec.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Read I/O States (RIO)	Immediate (Class "A")	21 (0x15)	NONE	NONE

Example:

Read back the **I/O State Word**

@16 21 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

I/O State Code 2 Bytes

Response Example:

Indicates lines #4, 5, 6, & 7 are "High" and lines #1, 2 & 3 are also "High"

 # 10 0015 F0F0 (CR)

Table Showing the Bit definitions for the I/O State Word (IOS)

Nibbles	Bit #	**IOS** bit # 15-8 definitions	Nibbles	Bit #	**IOS** bit # 0-7 definitions
"F"	Bit 15	I/O #7	"F"	Bit 7	Over Temperature ("0" = True)
	Bit 14	I/O #6		Bit 6	I/O #3
	Bit 13	I/O #5		Bit 5	I/O #2
	Bit 12	I/O #4		Bit 4	I/O #1
"0"	Bit 11	reserved	"0"	Bit 3	Trajectory Generator Active
	Bit 10	Delay Counter Active		Bit 2	External Index
	Bit 9	Holding Error		Bit 1	Internal Index
	Bit 8	Moving Error		Bit 0	INDEX (Multiplexed)

Read Internal Status Word (RIS)

Description:

The **Internal Status Word** is used in SilverMax to keep track of different conditions that are present in the motor. This word may need to be read if more information on the motor status is required. For example: Over and Under Voltage conditions can be checked when, for some reason, the motor shuts down during operation. This gives the system greater knowledge about the reasons for a shut down. The **Internal Status Word** can be cleared using the **Clear Internal Status** command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Read Internal Status Word (RIS)	Immediate (Class "A")	20 (0x14)	NONE	NONE

Example:

Read back the **Internal Status Word**

@16 20 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

State Code 2 Bytes

Response Example:

Indicates Input #1, 2, 3 "High" , Last Calculation was Zero and Index Sensor was found.

 # 10 0014 00F3 (CR)

Table Showing the Bit definitions for the Internal Status Word (ISW)

Nibbles	Latched	Bit #	**ISW** bit # 15-8 definitions	Nibbles	Bit #	Latched	**ISW** bit # 0-7 definitions
"0"		Bit 15	reserved	"F"	Bit 7	Yes	Over temperature ("0" = True)
	Yes	Bit 14	Low voltage		Bit 6	No	I/O #3
	Yes	Bit 13	Over voltage		Bit 5	No	I/O #2
	No	Bit 12	Wait Delay exhausted		Bit 4	No	I/O #1
"0"	Yes	Bit 11	Input found on last move	"3"	Bit 3	Yes	Negative **Calculation** result
	Yes	Bit 10	Halt command was sent		Bit 2	Yes	Positive **Calculation** result
	Yes	Bit 9	Holding error		Bit 1	Yes	Zero **Calculation** result
	Yes	Bit 8	Moving error		Bit 0	Yes	Index sensor found

Read Program Buffer (RPB)

Description:

Reads the Data that is currently contained in the **Program Buffer**. The specified number of Words is read from the **Program Buffer** starting with the given address. Up to 8 words can be read at one time. This limit is due to the size restriction of the **Serial Communications Buffer**. To read the entire contents of the **Program Buffer** multiple reads are required. For details on SilverMax memory management, see the User Manual section **Programming SilverMax**.

NOTE: When reading command codes from Program Buffer the MSB will be stripped off. For example, if an MRV command is read from the Program Buffer, it will be read as a 0x07 instead of a 0x87.

Command Info:

Command Name	Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Read Program Buffer (RPB)	Immediate (Class "A")	6 (0x6)	< Length > (in words)	1 to 8 (1 to 0x08)
			< Address >	0 to 199 (0 to 0x00C7)

Example:

Read the first 7 words from Program Buffer

@16 6 7 0 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

Buffer Data "Length" of Words

Response Example:

 # 10 0006 0007 0000 9C40 0002 7524 2000 0058 (CR)

Revision (RVN)

Description:

This command returns the revision date of this code, and the buffer sizes. The code revision date and buffer sizes of a SilverMax can be read back so that future upgrades can be dealt with through a software interface. This enables dynamic changes in SilverMax usage when different versions are used.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Revision (RVN)	Immediate (Class "A")	5 (0x05)	NONE	NONE

Example:

Read the revision code from SilverMax

@16 5 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

Revision Code (8 Bytes)

Response Example:

SilverMax Revision code

 # 10 0005 1116 1998 0108 0A34 (CR)

The following Revision information is available

Data Type	Data Format	Example Shown above
A. Month	1 Byte	"11" = November
B. Day	1 Byte	"16" = 16th day
C. Year	2 Bytes	"1998" = The year 1998
D. Options Number	2 Bytes	"0108" = Code rev 108
E. Serial Communications Buffer Size	1 Byte	"0A" = 10 Words
F. Program Buffer Size	1 Byte	"34" = 52 Words

Override Commands

Halt (HLT)

Description:

This command immediately shuts down any motion in progress (hard stop), disables the single step mode, and then causes the motor to load and run the Kill Recovery sequence.

This command stops the execution of all commands, programs and motions. When executed, it will stop any command or program in process. Unless the **Kill Recovery Routine** has been designated and the **Kill Enable Driver** has been enabled, the motor driver will be disabled. . This removes the drive to the motor and allows the motor shaft to spin freely. After this, the **KILL MOTOR RECOVERY** routine is called which allows the user to choose the recovery method. Running either the **ENABLE MOTOR DRIVER** command or re-initializing the **MOTOR CONSTANTS** (for earlier revisions) will put the motor back into position holding mode. Before doing this, the **SET TARGET TO POSITION** command should be issued to avoid sudden extreme movement of the motor.

Bit #10 of the **Internal Status Word** is "set" to indicate that a **Halt** command was sent. This is useful for determining the cause of the motor shut down when using an internal "**Kill Recovery Program**".

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Halt (HLT)	Immediate (Class "A")	2 (0x2)	NONE	NONE

Example:

Halt any Command, Program or Motion in process

@16 2 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

ACK only

Response Example:

Standard SilverMax Acknowledge

*** 10 (CR)**

Restart (RST)

Description:

The **Restart** command is provided to cause the unit to do a "Hard" reset of the processor and logic circuits. This causes the processor to jump to memory address zero as if the power were just cycled on. If this command does not function, then the SilverMax unit will require a full power down and up to reset the processor. All configurations and settings are returned to power-up defaults. Non-Volatile memory is not affected.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Stop (STP)	Immediate (Class "A")	4 (0x4)	NONE	NONE

Example:

Reset the SilverMax processor. This is done immediately with no response to the command

@16 4 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

No Response

Response Example:)

THERE IS NO RESPONSE DUE TO THE RESETTING OF THE PROCESSOR

Single Step Exit (SSE)

Description:

This command causes the SilverMax to Exit the single step program execution mode. When SilverMax has been placed into single step mode using the **Single Step Program** command this command takes SilverMax out of the single step mode and restores normal execution. If the program is not at its end, it will continue to execute until the end is reached. The **Halt**, **Stop**, **Kill Motor**, **Power Low** will also exit the single step mode and halt the program execution.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Single Step Exit (SSE)	Immediate (Class "C")	18 (0x12)	NONE	NONE

Example

Exit Program single step mode.

@16 18 (CR)

SilverMax Response:s

ACK only

Response Example

Standard SilverMax Acknowledge

*** 10 (CR)**

QuickControl Example:

Immediate (Host) Mode Command Only

Single Step Program (SSP)

Description:

Puts SilverMax into a program single step mode and executes the first command in the program or executes the next line in a program if already in single step mode. This command is used to step through a program that has been downloaded into the Program Buffer. Issuing this command will cause the next **Program Type** command to execute, then stop and wait for the next **Single Step Program** command.

If a program has previously been loaded into the **Program Buffer** either by using the **Load Program** command or by downloading from the Host, the **Run Program** must first be issued before the **Single Step Program** has effect.

A **Single Step Program** command can be issued before a program is loaded. This puts SilverMax into the Single Step mode that will wait until a program is loaded and then pause. When a **Load and Run Program** command is used, the first command of the program will not be executed. This is because the **Load and Run Program** command is a Program Type and acts like the first command in the program.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Single Step Program (SSP)	Immediate (Class "C")	17 (0x11)	NONE	NONE

Example:

Put SilverMax into Single Step Program mode or Step the program.

@16 17 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

ACK only

Response Example:

Standard SilverMax Acknowledge

*** 10 (CR)**

Stop (STP)

Description:

The **Stop** command exits the executing program or motion and goes into **Hold**. If a motion is running, the **Deceleration** parameter sets the deceleration as follows: If "0", it uses the executing command's acceleration value for deceleration. If this value is positive, it uses the given deceleration value. If the deceleration parameter is negative, the unit does an immediate stop (directly to Hold). The Target value is set to the present position. If the unit is not executing a motion, any Program type command executing is terminated and the unit returns to idle.

When the **Stop** command is sent the **Program Buffer** is over-written (similar to a **Clear Buffer**). The **Program Buffer** must be loaded again (**Load Program or Load and Run Program**) for Program execution.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Stop (STP)	Immediate (Class "A")	3 (0x3)	<<Deceleration>>	**-1** = Stop Immediate or **0** = Stop using previous Acceleration or 1 to 536,870,911 (1 to 0x1FFFFFFF)

Example:

Stop the SilverMax using the previous command Acceleration parameter

@16 3 0 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

Initialization Commands

ACK DELAY (ADL)

Description:

The **ACK Delay** sets a time delay for SilverMax to wait before sending an Acknowledgement (**ACK)** or **DATA** after a command has been received. In some cases, the host computer or PLC may not have enough time to set up for reception after having transmitted a command. The ACK Delay can be used to have SilverMax wait a predetermined length of time to allow for these delays. In the case where an RS-485 network in used, there is often a delay when going from transmit to receive for the RS-485 driver. Setting the delay allows the SilverMax to wait for the line to be free before attempting a transmission.

When the Serial interface is set to "RS-232" a value of "0" causes SilverMax to run in standard RS-232 mode (the Tx line is always driven). With a number of "1" or greater, SilverMax will run in RS-232 multi-drop mode (the Tx line is tri-stated when not transmitting).

The delay parameter is a count that equates to the servo cycle tick. One cycle tick is 120 microseconds. The default value for the delay count is 4, this gives a delay of approximately 0.5 milliseconds. The largest count that can be set is 21845 - this will give a delay of 2.6214 seconds.

When sending this command the delay takes effect before the Acknowledge is sent.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Ack Delay (ADL)	Program (Class "D")	173 (0xAD) [2 Words]	<Count in Ticks> 1 Tick = 120usec.	0 to 21845 (0 to 0x5555)

Example:

Delay **ACK** for 2.5 milliseconds

@16 173 20 (CR)

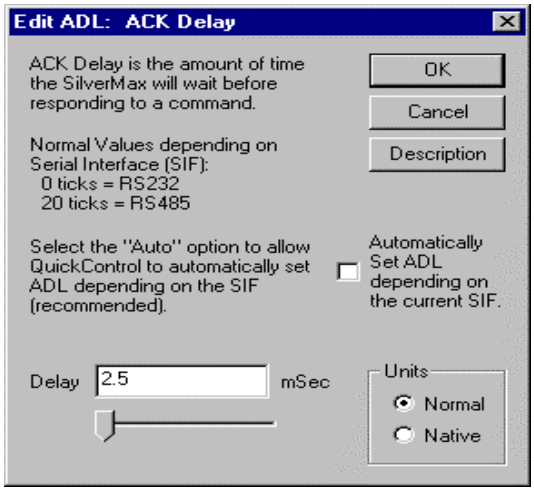
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:


Edit ADL: ACK Delay
ACK Delay is the amount of time the SilverMax will wait before responding to a command.
OK
Cancel
Description
Normal Values depending on Serial Interface (SIF):
0 ticks = RS232
20 ticks = RS485
Select the "Auto" option to allow QuickControl to automatically set ADL depending on the SIF (recommended).
Automatically Set ADL depending on the current SIF.
Delay
2.5
mSec
Units
Normal
Native

ANTI-HUNT CONSTANTS (AHC)

See Also: **TORQUE LIMITS (TQL), ANTI-HUNT DELAY (AHD)**

Description:

Anti-Hunt Constants set the thresholds used to determine if the position is sufficiently close to the target to allow the motor to go into and to stay in **Anti-hunt mode**. The first parameter is the maximum error (in counts) allowed in the Anti-Hunt mode before the unit will revert to normal closed loop operation. The second parameter is the maximum error allowed to enter the Anti-Hunt mode. Neither of these parameters should be larger than 30 counts for normal operation.

Setting the second parameter to a negative number will cause a slightly different operation when going from No Anti-Hunt into Anti-Hunt (Closed => Open). Normally SilverMax will not go into Anti-Hunt until the error is within the limit and the Closed Loop holding current is less than the Open Loop holding current. When the error parameter is negative, the Holding currents are not checked.

If the **TORQUE LIMITS Open Hold** and **Open Moving** parameters have been set to zero, then the parameters in this command set the limits of a conventional dead-band.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Anti-Hunt Constants (AHC)	Program (Class "D")	150 (0x96) [3 Words]	< Out of Anti-Hunt error > Open => Closed	0 to 35 (0 to 0x23)
			< Into Anti -Hunt error> Closed => Open	-35 to 35 (0 to 0x35 & 0xFFFF to 0xFFDD)

Example:

Go into Anti-Hunt when within "4" counts of target. Go out of Anti-Hunt when "10" counts away

@16 150 10 4 (CR)

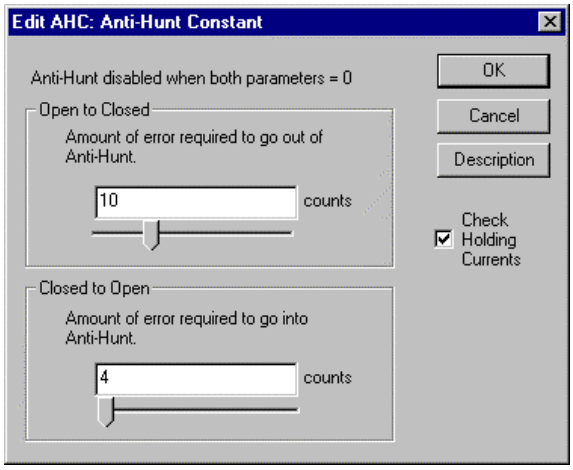
SilverMax Response:

ACK only

Response Example:

***10 (CR)**

QuickControl Example:



ANTI-HUNT DELAY (AHD)

See Also: **ANTI-HUNT CONSTANTS (AHC)**
ANTI-HUNT MODE (AHM)

Description:

The Anti-Hunt mode allows SilverMax to move from closed loop operation to open loop operation in order to eliminate servo dithering. The Anti-Hunt Constants determine when, based on position, this will occur. The **Anti-Hunt Delay** sets up a time delay from when a motion is complete to when the Anti-Hunt is allowed. This is useful for allowing a system time to "settle" prior to going into Anti-Hunt.

By default, the delay is set to "0". Settling time is a system parameter, which must be analyzed under real working conditions. Using the **SilverMax Tuning** tool in **QuickControl** allows viewing of motion profiles for analyzing settling times. This command is ignored when the **Anti-Hunt Mode** has been set to 1.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Anti-Hunt Delay (AHD)	Program (Class "D")	230 (0xE6) [2 Words]	< Count in Ticks > 1 Tick = 120usec.	0 to 65535 (0 to 0xFFFF)

Example:

Allow Anti-Hunt 10 milliseconds after a motion is completed.

@16 230 83 (CR)

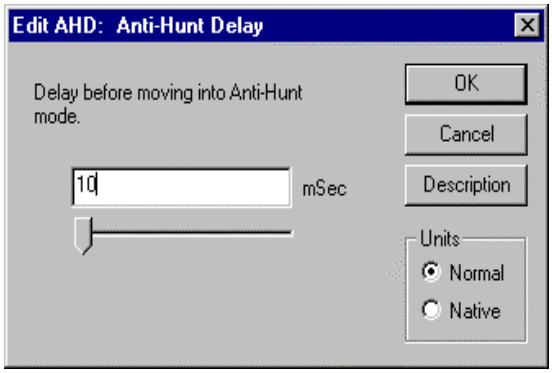
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



ANTI-HUNT MODE (AHM)

See Also: **ANTI-HUNT CONSTANTS (AHC)**
ANTI-HUNT DELAY (AHD)

Description:

The default mode of Anti-Hunt automatically switches from open loop to closed loop as soon as a motion begins, and then remains in closed loop for Anti-Hunt Delay time counts after the position error is less than the closed to open parameter. Anti-Hunt mode with Mode=1 bypasses the in motion check, allowing the motor to remain in open loop, even while moving, as long as the error is sufficiently low. A value of Mode=0 switches the Anti-Hunt function back to its default mode of operation.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Anti-Hunt Mode (AHM)	Program (Class "D")	219 (0xDB) [2 Words]	< Mode > 0 = only when stopped. (Default) 1 = moving or stopped.	0 or 1

Example:

Allow Anti-Hunt Mode only while stopped.

@16 219 0 (CR)

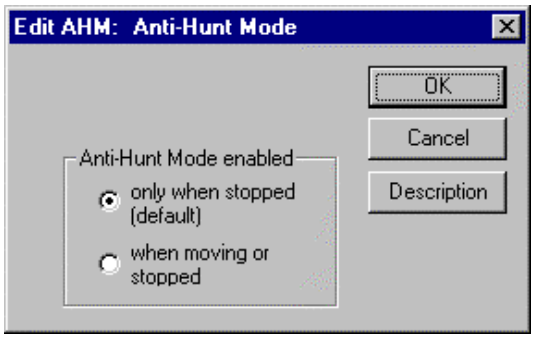
SilverMax Response:

ACK only

Response Example:

***10 (CR)**

QuickControl Example:



BAUD RATE (BRT)

Description:

If a Baud Rate different than the default rate is required, such as with a PLC limited to 9600 baud, the **Baud Rate** command can be used to change the baud rate to a range of other values. The baud rate is limited to a maximum value of 230400 bits per second. 57600 is the default baud at power up. Other baud rates can be set using "Speed" values from the table below.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Baud Rate (BRT)	Program (Class "D")	174 (0xAE) [2 Words]	< Speed>	3 = 300 (baud) 12 = 1200 24 = 2400 48 = 4800 96 = 9600 192 = 19200 288 = 28800 384 = 38400 576 = 57600 1000 =100000 1152 =115200 2304 =230400

Example:
(8-Bit ASCII Protocol)

Set the baud rate for 57.6K. This works with most PLCs.

@16 174 576 (CR)

SilverMax Response:

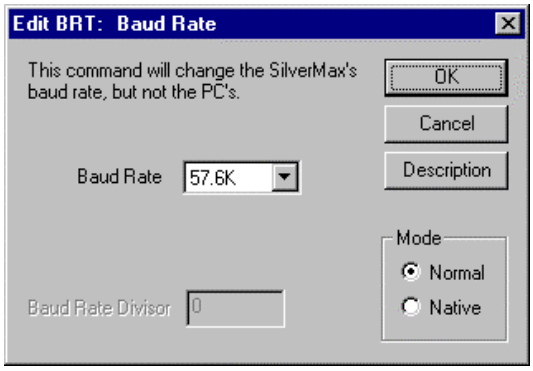
Description	Data Format (Hex)
ACK only	NONE

Response Example:

***10 (CR)**

NOTE: The baud rate changes immediately, so, if different than the current baud rate, the Acknowledge may not be intelligible.

QuickControl Example:



CALIBRATE ANALOG INPUT FROM NV (CAI)

Description:

This command loads the Analog Channel Calibration Factor and the Maximum over voltage shutdown voltage from **Non-Volatile Memory**. This data for each unit is determined and stored in a factory calibration procedure. The calibration data is stored as a long word into location 65524. The **CAI** command must be executed before the motor parameters are loaded, and before setting **the Low Voltage Trip** or **Over Voltage Trip** commands.

Command Info:

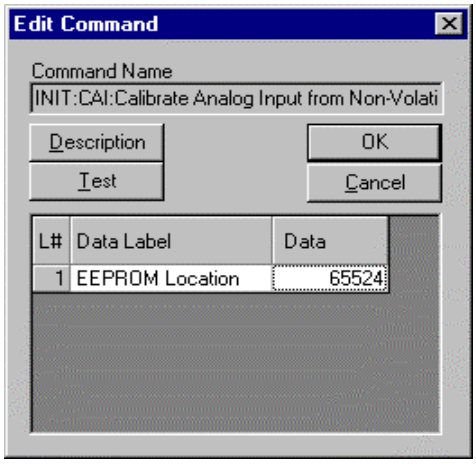
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Calibrate Analog Input From Nv (CAI)	Program (Class "D")	211 (0xD3) [2 Words]	<NV Memory Address>	Factory Default Calibration = 65524 (0xFFF4)

Example:

Calibrates the Power Supply analog channel and sets the maximum overvoltage shutdown voltage.

@16 211 65524 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

***10 (CR)**

CONTROL CONSTANTS (CTC)

See Also: **FILTER CONSTANTS (FLC)**

Description:

This command sets the various servo loop gain control constants. These are used in tuning the motor.

Gain term List -

Velocity #1 Feedback : Single filtered velocity feedback term
Velocity #2 Feedback : Double filtered velocity feedback term
Velocity Feedfoward: Velocity feedforward term
Acceleration Feedback: Acceleration estimator feedback term
Acceleration Feedforward: Acceleration feedforward term
Proportional: Position error feedback term
Integrator: Integration of the error feedback term summed with the three velocity terms.

(See "**Tuning SilverMax**" in the **SilverMax User Manual** for more details.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Control Constants (CTC)	Program (Class "D")	148 (0x94) [8 Words]	<Velocity 1 Feedback Gain>	0 to 32767 (0 to 0x7FFF)
			<Velocity 2 Feedback Gain>	0 to 32767 (0 to 0x7FFF)
			<Velocity Feedfoward Gain>	0 to 32767 (0 to 0x7FFF)
			<Acceleration Feedback Gain>	0 to 32767 (0 to 0x7FFF)
			<Acceleration Feedfoward Gain>	0 to 32767 (0 to 0x7FFF)
			<Proportional Gain>	0 to 32767 (0 to 0x7FFF)
			<Integrator Gain>	0 to 32767 (0 to 0x7FFF)

Example:

@16 148 0 10 10 10 10 200 1000 (CR)

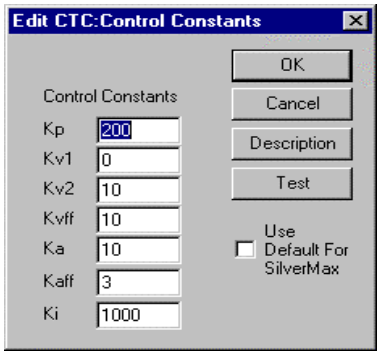
SilverMax Response:

ACK only

Response Example:

***10 (CR)**

QuickControl Example:



DISABLE DONE BIT (DDB)

See Also: **ENABLE DONE HIGH (EDH)**
ENABLE DONE LOW (EDL)

Description:

Disables the "Done" bit (I/O #1) on the motor. The "Done" bit indicates when the motor is running or idle (See **Enable Done Bit** for more details)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Disable Done Bit (DDB)	Program (Class "D")	171 (0xAB) [1 Word]	NONE	NONE

Example:

Disable usage of the "Done" bit

@16 171 (CR)

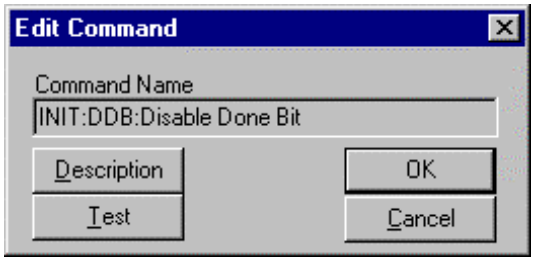
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



DIGITAL INPUT FILTER (DIF)

See Also: **I/O Commands**

Description:

Sets up a filter time constant for any of the seven digital inputs. A "0" in the I/O line parameter causes all of the input filter constants to be changed at the same time. Selecting 1,2, 3, 4, 5, 6 or 7 for the I/O line changes only the selected line.

The Filter constant is in "Ticks" (120 usec / tick). Setting the filter constant affects how long a digital state must be held for the SilverMax to “see” the given state.

NOTE: At power-up all filters are set to "0".

Command Info:

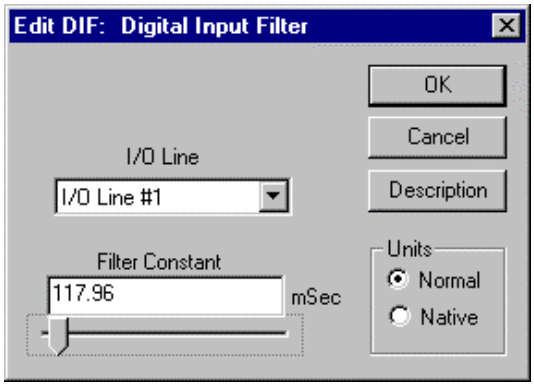
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Digital Input Filter (DIF)	Program (Class “D”)	252 (0xFC) [3 Words]	< I/O Line # >	0 = All Lines 1 to 7 (0 to 0x7)
			< Filter Constant>	0 to 32767 (0 to 0x7FFF)

Example:

Filter Input #1 so that it must be either low or high for as least 117.96 milliseconds before the low or high state is accepted.

@16 252 1 983 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR**

DIRECTION (DIR)

Description:

Establishes at initialization the direction the motor will turn by using a positive or negative number. Normally the SilverMax will turn Clockwise (when viewed from the shaft end of motor) when a positive distance or velocity number is used. A negative number will cause the motor to turn counter clockwise. Using the **Direction** command, this default operation can be reversed.

NOTE: This command can only be used when SilverMax is in the **Open Loop** mode and should be set during the power up initialization process of SilverMax before the initial torque command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Direction (DIR)	Program (Class "D")	184 (0xB8) [2 Words]	<Selection>	0 = Normal (CW) 1 = Reverse

Example:

Clockwise

@16 184 0 (CR)

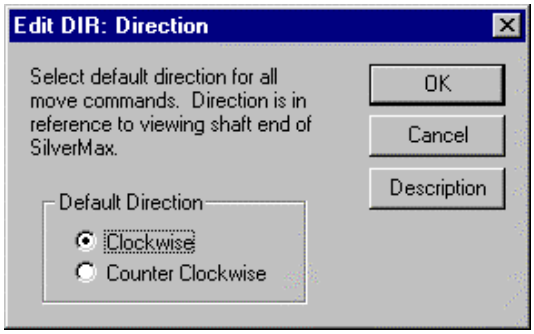
SilverMax Response:

ACK only

Response Example:

*** 10 (CR**

QuickControl Example:



DUAL LOOP CONTROL (DLC)

See Also: **SELECT EXTERNAL ENCODER (SEE), SINGLE LOOP CONTROL (SLC)**

Description:

Configures SilverMax to run in a **Dual Loop** control mode. In **Dual Loop Control,** the SilverMax servos its position based on an **External Encoder** signal. SilverMax commutation, velocity and acceleration feedback information is derived from the **Internal Encoder**. Moving and Holding error limits also use the External Encoder for the **Kill Motor Conditions**.

The Anti-Hunt mode uses the **Position Error** derived from the **External Encoder** to establish when to move in and out of **Anti-Hunt mode**. The **ANTI-HUNT CONSTANTS** "**Closed => Open**" parameter should be set to "1" so that an error of "0" will allow entry into Anti-Hunt.

When position control of the driven device is needed, this command along with an External Encoder connected to the device, will enable direct position control of the device. When using a linear slider, a linear encoder can be used for the **External Encoder** signal.

When entering dual loop control SilverMax sets the current "Target" to the "Current position" (External Position) to prevent a sudden motion.

SilverMax must be in **Closed Loop Mode** for this command to take effect.

By default, SilverMax starts up in **Single Loop Control** mode. The **Dual Loop Control** command can be placed within a User Program to place the motor properly into **Dual Loop Control**. Use of a single loop move prior to entering dual loop move may be used to verify that the external encoder is connected and operational.

The **External Encoder** settings should be initialized prior to using this command or unpredictable results may occur. Use the **Select External Encoder** command to set up the external encoder usage.

NOTE: The **Control Constants** typically need to be configured differently for single loop operation than for dual loop operation. The Velocity and Acceleration parameters for motions become related to external encoder counts rather than internal encoder units. The feedforward acceleration and velocity terms are relative to full speed in external encoder units while the feedback terms are relative to the internal encoder units, thus the feedback terms may need to be different from the feedfoward terms in order to minimize following error. If the external encoder has three times the resolution of the internal encoder, then the feedback terms need to be three times as large as the feedforward terms to balance their gains.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Dual Loop Control (DLC)	Program (Class "D")	243 (0xF3) [1 Word]	NONE	NONE

Example:

Configure SilverMax for Dual Loop Control

@16 243 (CR)

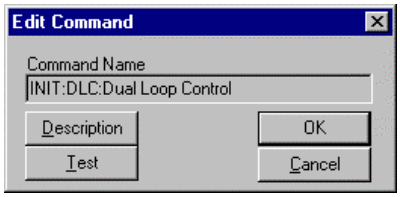
SilverMax Response:

ACK only

Response Example:

*** 10 (CR**

QuickControl Example:



DISABLE MOTOR DRIVER (DMD)

See Also: **ENABLE MOTOR DRIVER (EMD)**

Description:

Disables the motor driver and shorts the windings together. The SilverMax will be unable to move when attempting any motion command. This is a software disable that can be overcome by the **Enable Motor Driver** command, or by setting the **Motor Constants**.

Command Info:

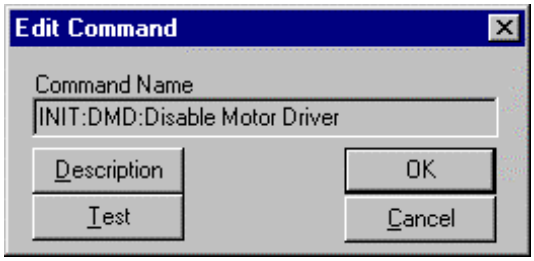
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Disable Motor Driver (DMD)	Program (Class "D")	228 (0xE4) [1 Word]	NONE	NONE

Example:

Disable the Motor Driver electronics

@16 228 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

DISABLE MULTI-TASKING (DMT)

See Also: **ENABLE MULTI-TASKING (EMT)**

Description:

Disables SilverMax **Multi-Tasking** operation. SilverMax executes Programs in a sequential manner by executing each command until completion before moving to the next. See **Enable Multi-Tasking** for more information on Multi-Tasking operation. If a motion is active, the next program line will not be executed until the motion has completed.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Disable Multi-Tasking (DMT)	Program (Class "D")	226 (0xE2) [1 Word]	NONE	NONE

Example:

Disable the Multi-Tasking operation

@16 226 (CR)

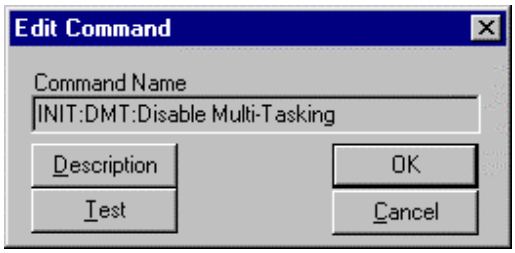
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



ENABLE DONE HIGH (EDH)

See Also: **DISABLE DONE BIT (DDB)**
ENABLE DONE LOW (EDL)

Description:

Enables a "Done" indication on the motor I/O Line #1. The "Done" indicates when the motor is idle and within the set **Error Limits**. When the motor is idle (Hold mode) the Done indicator will be **High** ("1"). During the execution of a motion profile command the Done indicator will go **Low** ("0") indicating the motor is moving. It will then go **high** at the end of the motion.

If the motor position during the move or when holding exceeds the error limits, the bit will go **low** or remain **Low** even when a motion completes.

PLCs or Host Controllers can use the "Done" indication for monitoring SilverMax motions to check for completion.

When in Step & Direction mode and no multi-tasking program is running, the "Done" only indicates position errors.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Enable Done High (EDH)	Program (Class "D")	251 (0xFB) [1 Word]	NONE	NONE

Example:

Enable usage of the "Done" indication by setting I/O line #1 **High**

@16 251 (CR)

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:

ENABLE DONE LOW (EDL)

See Also: **DISABLE DONE BIT (DDB)**
ENABLE DONE HIGH (EDH)

Description:

Enables a "Done" indication on the motor I/O Line #1. The "Done" indicates when the motor is idle and within the set **Error Limits**. When the motor is idle (Hold mode) the Done indicator will be **Low** ("0"). During the execution of a motion profile command the done indicator will go **High** ("1") indicating the motor is moving. It will then go low at the end of the motion.

If the motor position during the move or when holding exceeds the error limits, the bit will go **high** or remain **High** even when a motion completes.

PLCs or Host Controllers can use the "Done" indication for monitoring SilverMax motions to check for completion.

When in Step & Direction mode and no multitasking program is running, the "Done" only indicates position errors.

Command Info:

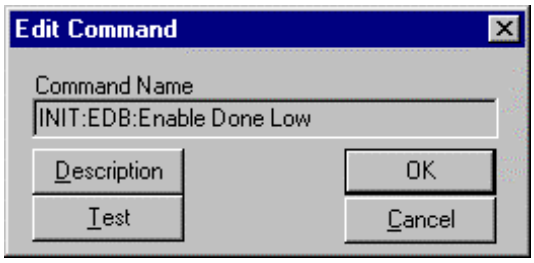
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Enable Done Low (EDL)	Program (Class "D")	187 (0xBB) [1 Word]	NONE	NONE

Example:

Enable usage of the "Done" indication by setting I/O line #1 **Low**

@16 187 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR**)

ENABLE MOTOR DRIVER (EMD)

See Also: **DISABLE MOTOR DRIVER (DMD)**

Description:

Enables the SilverMax motor driver. The driver is by default enabled, this command is only required if the driver has been disabled using the **Disable Motor Driver** command or disabled by the **Kill Motor** operation or by an over voltage condition.

Command Info:

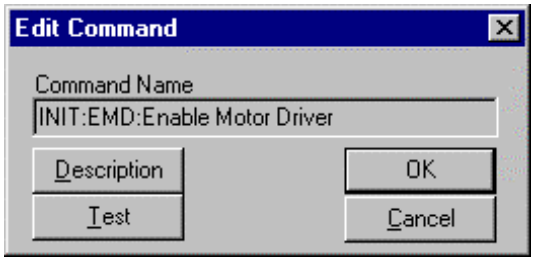
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Enable Motor Driver (EMD)	Program (Class "D")	227 (0xE3) [1 Word]	NONE	NONE

Example:

Enable the SilverMax motor driver

@16 227 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR**)

ENABLE MULTI-TASKING (EMT)

See Also: **DISABLE MULTI-TASKING (DMT)**

Description:

Enables SilverMax "Multi-Tasking" operation, which allows Motion while executing a program. By default, SilverMax does not continue internal program execution when performing a motion command or while executing in a **Velocity Mode, Step and Direction** Mode or **Input Mode**. **Enable Multi-Tasking** causes SilverMax to continue program execution after a motion command or mode has been started.

Multi-Tasking is useful for conditions where the SilverMax is acting as a Master controller and must initiate other tasks while performing motions. An example of this is performing I/O operations for controlling other machine functions. SilverMax will be able to "Set" or "Clear" the I/O lines at any time. Many other things can be done including modifying motion profiles on-the-fly when executing a **Profile Move** command or the **Register Step and Direction** command.

Multi-Tasking rules of engagement when enabled:

Time and Velocity based motion commands (Absolute or Relative, Direct or Register-based): These commands start by loading the move parameters into the "**Calculation task**", and wait until the calculation is done (to check for errors) before turning it over to the **Trajectory Generator**. The next command in the **Command Buffer** may not proceed until the pre-move calculation has completed (1.5 milliseconds). If the next command is a **Motion** command and the previous motion command is still active, a "Busy" state will occur that will cause a "Wait" for the prior motion to complete before starting. This acts to buffer the second motion command and will cause the program to hold until the second motion command has completed its **Calculation Task**. No error is generated.

NOTE: **Step and Direction Mode, Velocity Mode, Input Mode** or a **Profile Move** is NOT terminated by a **Motion** command when in Multi-Tasking operation. These other modes or operations must be explicitly terminated or completed before a move is initiated.

Velocity Mode command: This command does not check the "Busy" status when executed. It just jumps in and takes over from wherever a motion is executing. The **Step and Direction Mode**, **Input Modes** or a **Profile Move** can be taken over by the **Velocity Mode. Velocity Mode** can be used to decelerate from **any of these** operations to a stop using a given deceleration.

Profiled Move Override: This command does not check the "Busy" status when executed. It starts up with the existing position and velocity and continues from there applying the new parameters. It can be used to take over any existing motion.

Profiled Move Exit: This command does not check the "Busy" status. It uses the Profiled Deceleration parameter to bring any current motion to a stop.

Target Offset command: This command may be used to offset the current value of the **Trajectory Generator** (hopefully a little at a time), even while other motions or modes are running. When in Multi-Tasking this could facilitate a skew forward or skew back while in the **Step and Direction** Mode. This command only affects the Target, and thus does not affect open loop operation.

Step and Direction commands: These commands can only be over-written by another **Step and Direction** command, **Velocity Mode** command, **Hard Stop Move** command**, Profiled Move Override** command or **Profiled Move Exit** command. After the commands have executed (done in one time slice), the program moves to the next command in the **Command Buffer**. When **Multi-Tasking** is disabled program execution halts at these commands until a stop condition occurs.

NOTE: The **Registered Step and Direction** command has another benefit in that the scaling value, stored in a **User Data Register**, may be dynamically modified with continuing program

statements to implement ramp-up, ramp-down and synchronization functions. (See **Registered Step and Direction** command for more information)

(Continued on next page)

Input Mode commands: The mode parameters, contained in **User Data Registers** 12 – 18, may be dynamically modified, using the Write Register commands , in continuing program statements while operating in the any of the **Input Modes**.

Profile Move commands: These commands can only be over-written by a **Profile Move Override** command, the **Profile Move Exit** command or by the **Velocity Mode**. They operate using **User Data Registers** for the motion parameters. The **Data Registers** can be updated at any time from a Host controller using the serial interface. This can be done regardless of the Multi-Tasking state. If however, an internal program is used to modify the **Data Registers, Multi-Tasking** must be enabled. After a **Profile Move** command is executed, continuing program statements may be used to dynamically modify the **Data Registers**. (See **Profile Move** commands for more information on usage.)

Program End command: If multitasking is enabled, and this command is encountered the executing program exits and the **Program Complete** status bit is set in the **Polling Status Word**. If there is an active motion command, it will continue execution until complete; (delayed until motions or modes have completed if not set for Multi-Tasking operation); when this motion or mode completes, status bit 15 (foreground complete) in the **Polling Status Word** is set.

Halt command: Runs the **Kill Recovery** command after setting the **Halt** bit in the **Internal Status Word**. The current motion or mode is terminated. The motor driver will remain "enabled" if the **Kill Enable Driver** command has been issued. Without **Multi-Tasking,** the motor driver is always disabled regardless of the **Enable Driver** state.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Enable Multi-Tasking (EMT)	Program (Class "D")	225 (0xE1) [1 Word]	NONE	NONE

Example:

Enable Multi-Tasking operation

@16 225 (CR)

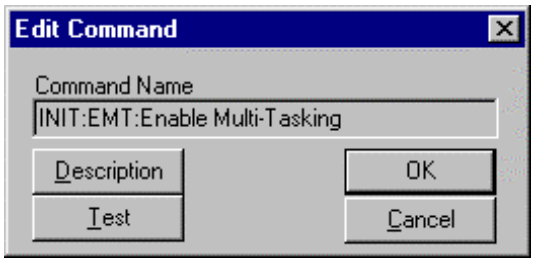
SilverMax Response:

ACK only

Response Example:

*** 10 (CR**)

QuickControl Example:



ERROR LIMITS (ERL)

See Also: **KILL MOTOR CONDITIONS (KMC)**

Description:

Error Limits sets the **Moving Error** limits, the **Holding Error** limits, and the **Delay to Hold** time following a motion before the motor uses the holding torque limit setting and the holding error limits. At the completion of a motion (the Trajectory Generator has completed the move calculation), the **Delay to Holding** counter will begin counting down. When the count reaches zero (one count per 120 microseconds), the motor changes to **Hold Mode**. The **Moving Error** limit is always checked, while the **Holding Error** limit is only checked while in the **Hold Mode**.

The **Delay to Holding** also controls when the SilverMax will switch from the **Moving** torque limits to the **Holding** torque limits. Lower closed holding torques may be used to reduce heating in the case of a stall or jam. Reduced open holding torques may be used to reduce heating when in anti-hunt mode.

Error conditions are set in both the **Internal Status Word** and in the **Polling Status Word** if the error limits are exceeded. The **Polling Status Word** error condition can alert the Host controller to the condition if the unit is being polled. The conditions in the **Internal Status Word** may be used to halt the motor in the case of a motion error. (See the **Kill Motor** command for more information on halting a motor.)

A special "Drag" mode may be implemented by setting the error limits to negative values. The absolute value of the limit is used to generate the status conditions, while the **Target** is not allowed to get farther than the respective error limit from the motor position. This can be used to set up a "clutch" mode where the output shaft can be dragged around to a desired position and the system will then maintain that position. This is useful for some mechanical alignment procedures, as well as for implementing drag clutch operations. Combining the **Drag** mode with the **Profiled Move** commands allows obstructions or other torque limited operation to recover while maintaining the requested velocity when the obstruction is removed. The Profiled Moves will continue to the requested position even if the drag mode is engaged. The **Kill Motor Conditions** should not be enabled if using this mode (The motor will shut down).

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Error Limits (ERL)	Program (Class "D")	151 (0x97) [4 Words]	< Moving limit >	-32768 to 32767 (0 to 0xFFFF)
			< Holding limit >	-32768 to 32767 (0 to 0xFFFF)
			< Delay to Holding > (1 tick = 120usec.)	0 to 65535 (0 to FFFF)

Example:

Allow 500 counts of error while moving and 100 counts of error when holding position. Allow 120 milliseconds before going into Hold mode with its tighter error limit.

@16 151 500 100 1000 (CR)

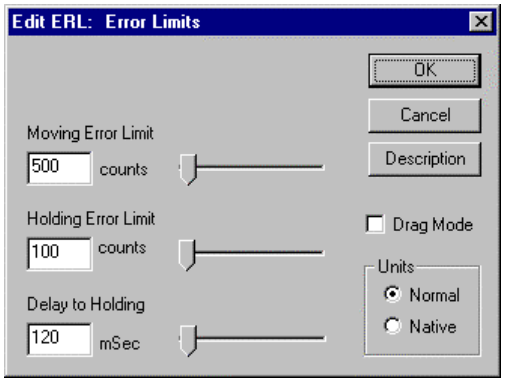
SilverMax Response:

ACK only

Response Example:

*** 10 (CR**)

QuickControl Example:



FILTER CONSTANTS (FLC)

Description:

Filter Constants selects the cutoff frequency for the velocity and acceleration filters. See "**Filter Parameters**" in the beginning of this manual for details on converting the filter values from Hz to native SilverMax units.

The filter cutoff frequencies affect the motor tuning.
(See "**Tuning SilverMax**" in the **SilverMax User Manual** for more details on using this command.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Filter Constants (FLC)	Program (Class "D")	169 (0xA9) [4 Words]	< Velocity 1 Feedback >	0 to 32767 (0 to 0x7FFF)
			< Velocity 2 Feedback >	0 to 32767 (0 to 0x7FFF)
			< Acceleration Feedback >	0 to 32767 (0 to 0x7FFF)

Example:

Set filters to roll of at 469, 413 and 117 Hz.

$23000 = 32768\ e^{-(469)2\pi(120uS)}$
$24000 = 32768\ e^{-(413)2\pi(120uS)}$
$30000 = 32768\ e^{-(117)2\pi(120uS)}$

@16 169 23000 24000 30000 (CR)

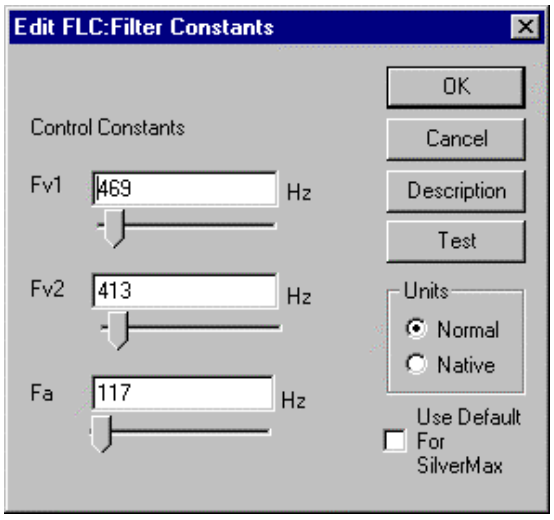
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



GRAVITY OFFSET CONSTANTS (GOC)

Description:

Establishes a value that compensates for the effects of gravity on the load that the motor is driving. This servo control parameter is designed to neutralize the effect of gravity on mechanisms that operate in other than horizontal orientation. It enables the servo control to operate consistently in both directions of motor rotation by creating a Torque offset that counters the torque required to hold the load in position.

The offset value is in torque units the same as the **Torque Limits** command. If, for example, it requires ¼ of the motor's torque capability to hold the load in position, the value may be set to approximately ¼ of the 100% torque value. (If the full torque value were 20000, the ¼ value would be 5000)

Depending on the direction of the Torque applied to the motor shaft, the value can be set to a negative or positive value.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Gravity Offset Constant (GOC)	Program (Class "D")	237 (0xED) [2 Words]	< Gravity Offset >	-32767 to 32767 (0 to 0x7FFF)

Example:

Set the Gravity Offset to 35% Torque for a QCI-23-3 motor

@16 237 7000 (CR)

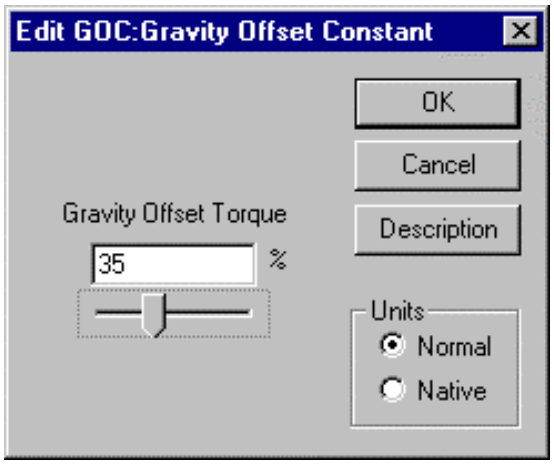
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



IDENTITY (IDT)

Description:

The **Identity** command is used to select the Unit ID and Group ID addresses to which the SilverMax will respond. The SilverMax will accept and respond to any command addressed with the Unit identifier. The SilverMax will accept commands sent to either the **Group Identifier** or to the **Global Identifier** (255), but no response will be sent as multiple units cannot respond at the same instant. No two units should have the same Unit identity when connected on the same network. Multiple units may share a common Group identity when they are on the same network.

Identities need to be in the range of 1 to 254.

Upon issuing this command, the SilverMax will respond with the new identifier.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Identity (IDT)	Program (Class "D")	155 (0x9B) [2 Words]	<Group + Unit Identity> Group = Upper Byte Unit = Lower Byte	257 to 65278 (0x0101 to 0xFEFE)

Example:

To Calculate number: Multiply the Group Identity times 256, then add the Unit Identity

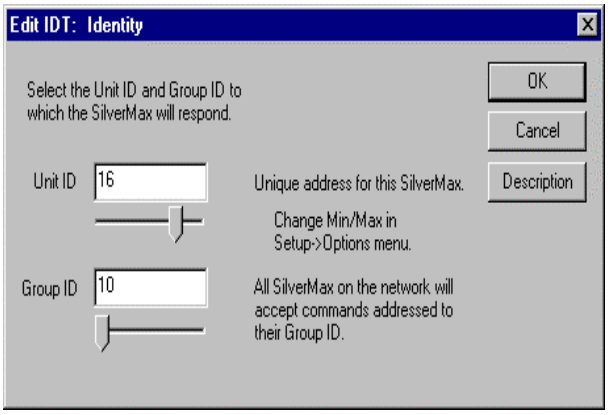
Group = 10, Unit = 16

Identity = (10 * 256) + 16 = 2576

Group Identity of 10, Unit Identity of 16;

@16 155 2576 (CR)

QuickControl Example:


Edit IDT: Identity
Select the Unit ID and Group ID to which the SilverMax will respond.
OK
Cancel
Description
Unit ID
16
Unique address for this SilverMax.
Change Min/Max in Setup->Options menu.
Group ID
10
All SilverMax on the network will accept commands addressed to their Group ID.

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

KILL DISABLE DRIVER (KDD)

See Also: **KILL ENABLE DRIVER (KED)**

Description:

Disables the motor driver, shorting across the windings (passive braking) when a **Kill Motor Condition** is met. If the SilverMax is moving, it will stop immediately in a rapid manner. The motor will be unable to move until re-enabled using the **Enable Motor Driver** command. This is the default setting for the motor.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Kill Disable Driver (KDD)	Program (Class "D")	183 (0XB7) [1 Word]	NONE	NONE

Example:

Disable the Motor Driver electronics when Kill Motor Conditions are met

@16 183 (CR)

QuickControl Example:

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

KILL ENABLE DRIVER (KED)

See Also: **KILL DISABLE DRIVER (KDD), ENABLE MULTI-TASK (EMT)**

Description:

Causes SilverMax to leave the motor drivers enabled when a **Kill Motor Condition** is met. Normally the motor driver is disabled with a **Kill Motor Condition**, this command can be used to leave the driver enabled if continuing operation is required.

In order for this command to function, SilverMax must be set up for Multi-Tasking operation (See **Enable Multi-Task**). Without **Multi-Tasking,** the driver will be disabled when **a Kill Motor Condition** occurs.

This command is very useful for times when a controlled shutdown of the motor is needed. For example, if there is a need to slowly ramp down the speed of the motor a **Velocity Mode, Program Type** command can be used in the **Kill Recovery** program to decelerate to zero speed with the given deceleration.

Command Info:

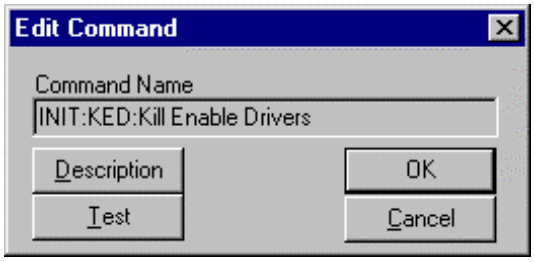
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Kill Enable Driver (KED)	Program (Class "D")	182 (0xB6) [1 Word]	NONE	NONE

Example:

Leave the SilverMax motor driver enabled

@16 182 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

KILL MOTOR CONDITIONS (KMC)

See Also: **KILL MOTOR RECOVERY (KMR)**

Description:

The **Kill Motor Conditions** allows the user to select what conditions will allow a controlled shutdown of the SilverMax unit. The **Condition Enable** word selects which bits in the **Internal Status Word** will be evaluated. Conditions are enabled by setting a "1" in the desired bit position of the **Condition Enable** binary word. The **Condition State** word allows the user to specify the state of the selected conditions that will cause the motor to do a controlled shutdown. Normal usage will include the **Over Temperature** state (Bit #7) in order to prevent unexpected motor restarts when the case temperature has returned to allowable temperatures. Some users may use the **Moving Error** bit to shut down the motor if the expected moving position error has been exceeded, as would be caused by a jam or obstruction. Digital inputs can also be used to implement a shut down from "End of Travel" limits if external switches are provided. Additionally, the **Wait Delay** function could be used as a watchdog timer if the wait function were not needed within the user Program (writing the wait with the no delay option would keep this number from expiring to zero). Note: **Over-voltage** is always enabled whenever the driver is enabled to protect the drivers from over voltage. An over-voltage condition will always disable the drivers regardless of the of Kill Enable Drivers state.

What Happens when the Kill Motor is tripped:

Bit 3 of the **Status Word** is set to indicate a shutdown.

If no **Kill Motor Recovery** routine has been designated by using the **Kill Motor Recovery** command, then the motor drivers are disabled, and any running program and moves are terminated.

If a **Kill Motor Recovery** routine has been designated, the drivers will be disabled and the active motion terminated unless both **Kill Enable Driver** and **Enable Multitasking** are active. The designated recovery routine will be loaded and executed. Note: Setting both the **Kill Enable Driver** and **Enable Multitasking** modes allows the recovery routine to shutdown the active motion by use of a **Velocity Mode** command or a **Profile Move End** with a zero velocity and a user acceleration.

All recovery routines should **Set Target to Position** before re-enabling the motor drivers to prevent a sudden movement of the motor. This movement occurs when the re-enabled control loop attempts to remove all of the position error that has accumulated since the driver became disabled.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Kill Motor Conditions (KMC)	Program (Class "D")	167 (0xA7) [3 Words]	<Condition Enable>	0 to 65535 (0 to 0xFFFF)
			<Condition State>	0 to 65535 (0 to 0xFFFF)

(Continued on next page)

KILL MOTOR CONDITIONS (KMC)

Example:

Shut down motor for a Moving or Holding Error, Over Temperature or Input #1 HIGH.

@16 167 912 784 (CR)

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:

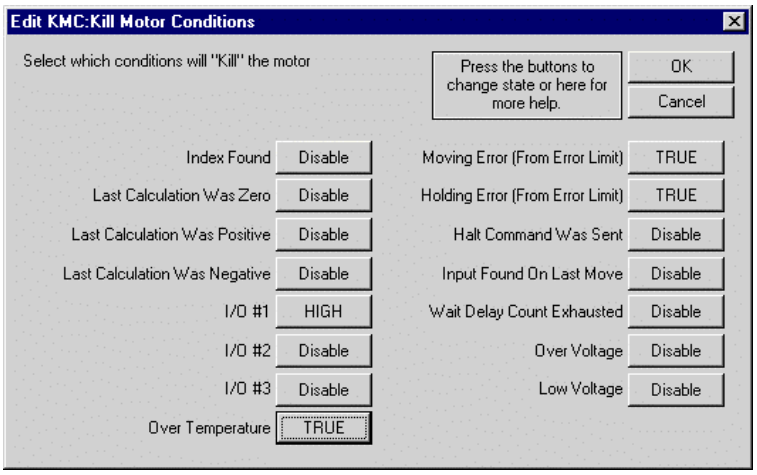


Table Showing the Bit definitions for the Internal Status Word (ISW)

	Bit #	**ISW** bit # 15-8 definitions		Bit #	**ISW** bit # 0-7 definitions
	Bit 15	Reserved	X	Bit 7	Over temperature ("0" = True)
	Bit 14	Low voltage		Bit 6	I/O #3
	Bit 13	Over voltage		Bit 5	I/O #2
	Bit 12	Wait Delay exhausted	X	Bit 4	I/O #1
	Bit 11	Input found on last move		Bit 3	Negative **Calculation** result
	Bit 10	Halt command was sent		Bit 2	Positive **Calculation** result
X	Bit 9	Holding error		Bit 1	Zero **Calculation** result
X	Bit 8	Moving error		Bit 0	Index sensor found

Condition Enable Word - Place a "1" in bit that is to be used

Bit # (for reference)	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Bit Values (For reference)	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*
Binary Word	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0
Nibbles	**0**				**3**				**9**				**0**			
Hexadecimal Word	**0390**															

Hexadecimal 0x0390 = 912 in decimal (Over-Temperature is enabled)

Condition State Word - Place a "1" in bit that is to be used

Bit # (for reference)	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Bit Values (For reference)	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*
Binary Word	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
Nibbles	**0**				**3**				**1**				**0**			
Hexadecimal Word	**0310**															

Hexadecimal 0x0310 = 784 in decimal

KILL MOTOR RECOVERY (KMR)

See Also: **KILL MOTOR CONDITIONS (KMC)**

Description:

The **Kill Motor Recovery** sets up options for recovery from a motor shut down. The **Kill Motor Conditions** establishes conditions that will cause the motor to shut down. Using the **Kill Motor Recovery** the motor can perform a standard or user defined process for re-initializing the motor. User Programs can be executed that have been previously stored in the motor non-volatile memory. (See **Kill Motor Conditions** for more detail.)

Three Options available:

"0" – This default state indicates that no recovery program has been designated. The SilverMax drops out of any motion or program that is currently executing and goes into an idle state. The drivers are disabled. At this point SilverMax will sit with no current to the motor, waiting for host intervention using the Serial Interface.

"-1" – Normal operation: -1 is a special parameter value indicating to run the default power up initialization from location "0"

"####" – Normal operation: The routine located at #### is loaded and executed.

See **Kill Motor Mask** for actions taken before the loading of the **Kill Motor Recovery** routine.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Kill Motor Recovery (KMR)	Program (Class "D")	181 (0xB5) [2 Words]	<process>	0 = Do Nothing -1 = Jump to NV Memory address 0. 1 to 3839 = NV Memory address. (1 to 0x0EFF)

Example:

After motor shut, down Jump to Program at "150".

@16 181 150 (CR)

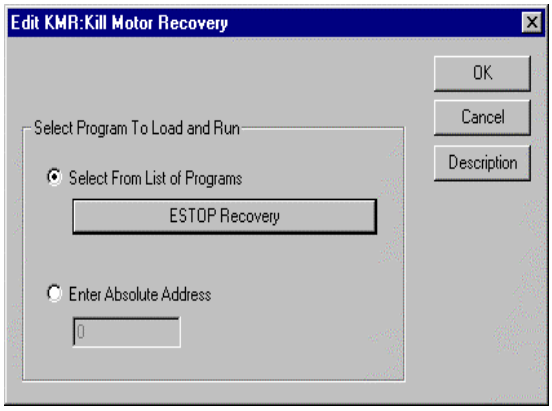
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



LOW VOLTAGE TRIP (LVT)

See Also: **POWER LOW RECOVERY (PLR)**

Description:

Used in conjunction with the **Power Low Recovery** command, this command sets the input voltage that will trigger a **Low Voltage** status (Bit #14 in the **Internal Status Word**). When a **Low Voltage Trip** occurs the low voltage trip value is overwritten to zero to prevent multiple triggering. The **Low Voltage Recovery** parameter is checked to see if a recovery routine has been configured. If none has been configured (value=0), then the motion and the program are immediately stopped. If a recovery routine has been configured via the **Power Low Recovery** command, and multitasking has been enabled, then the active motion is allowed to continue, and the recovery routine is loaded and run. If the multitasking is not enabled, then the motion is ended and then the recovery routine is loaded and run.

This command allows the user to shut down the motor properly when power is lost. The current position of the motor, for example, could be stored to non-volatile memory for pseudo absolute-encoder functionality.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Low Voltage Trip (LVT)	Program (Class "D")	212 (0xD4) [2 Words]	<Voltage>	0 = Don't Check 10 to 48 (0x0A to 0x30)

Example:

Set Motor to shut down at 10 volts

@16 212 10 (CR)

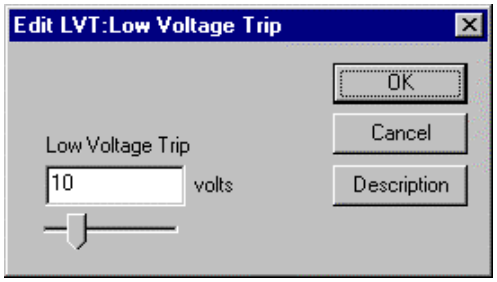
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



MOTOR CONSTANTS (MCT)

Description:

This command initializes the driver stage to produce appropriate drive signals to the motor dependant on both the motor type and the supply voltage. These constants are factory supplied for the selected motor at the requested power supply voltage.

When writing these parameters to the motor, it causes the motor driver to be "Enabled". This will over-ride a disabled driver condition whether it was commanded by a **Disable Motor Driver** or initiated by a **kill Motor Condition**.

The parameters for this command must be obtained from the factory. Normally these are set using the **Initialize SilverMax** tool in the **QuickControl** software where the desired voltage can be selected from a menu. (See "**Initialization**" in the **SilverMax User Manual** for more information on SilverMax motor initialization.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Control Constants (CTC)	Program (Class "D")	168 (0xA8) [9 Words]	< MC1 >	0 to 32767 (0 to 0x7FFF)
			< MC2 >	0 to 32767 (0 to 0x7FFF)
			< MC3 >	0 to 32767 (0 to 0x7FFF)
			< MC4 >	0 to 32767 (0 to 0x7FFF)
			< MC5 >	0 to 32767 (0 to 0x7FFF)
			< MC6 >	0 to 32767 (0 to 0x7FFF)
			< MC7 >	0 to 32767 (0 to 0x7FFF)
			< MC8 >	0 to 32767 (0 to 0x7FFF)

Example:

Set up a 23-5 for 24 volt operation

@16 168 1631 14843 31816 2057 1758 2329 32767 8213 (CR)

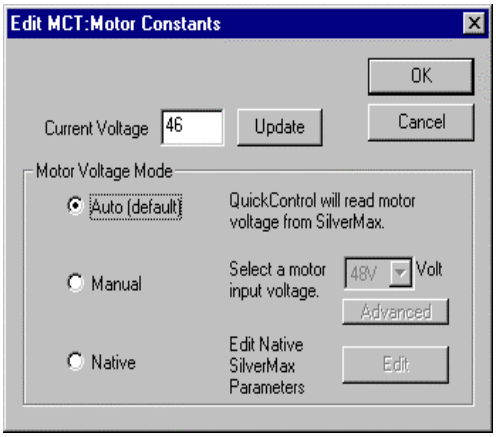
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



MAXIMUM TEMPERATURE TRIP (MTT)

Description:

Sets the temperature at which SilverMax will shut down the motor. This is used to prevent internal over-heating of the motor electronics. The value is entered in degrees Celsius integer units. (Example "70" for 70 degrees Celsius). The maximum temperature error condition is OR-ed with the motor driver over temperature condition. Either active will cause an **Over Temperature** status condition in the **Internal Status Word**. The temperature can be read using the **ANALOG READ INPUT** command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Maximum Temperature Trip (MTT)	Program (Class "D")	214 (0xD6) [2 Words]	<Temperature> Temperature in °C	0 = Don't Check 1 to 70 (1 to 0x46)

Example:

Set Motor to give an error at 70 degrees C

@16 214 70 (CR)

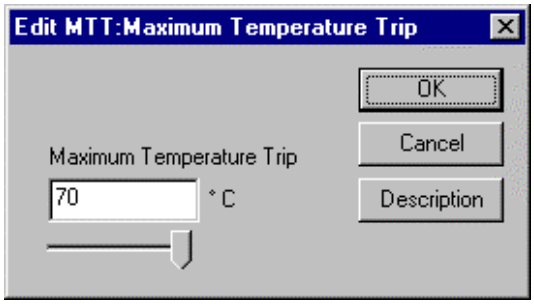
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



OPEN LOOP PHASE (OLP)

Description:

The **Open Loop Phase** is used to set initial motor phase prior to doing motor/encoder alignment. It is primarily used as an element in the algorithmic motor to encoder alignment routine. For values between zero and seventy-nine, this represents the micro-step position of the motor at 20 micro-steps per step. Negative values are used to select half step positions – i.e. –2 sets the motor at 1 full step away from a value of 0. Please see the **Initialization** section in the **SilverMax User Manual** for a more detailed description of the initialization process. This command is normally used only in the initialization procedure.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Open Loop Phase (LVT)	Program (Class "D")	152 (0x98) [2 Words]	< Angle in Counts >	-7 to 79 (0 to 0x004F & 0xFFF9 to FFFF)

Example:

Set the open loop phase to "0"

@16 152 0 (CR)

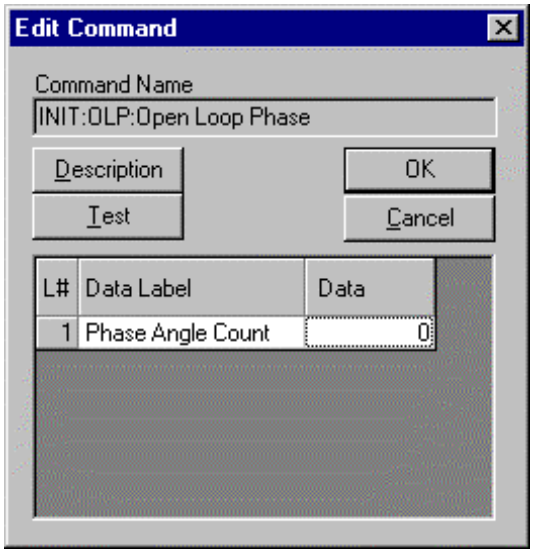
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



OVER VOLTAGE TRIP (OVT)

See Also: **KILL MOTOR RECOVERY (KMR)**

Description:

Sets the voltage at which SilverMax will cause a motor shutdown. This command is mainly used to prevent over-voltage from the power regenerated during deceleration. The voltage value is entered in integer units (example: "48" for 48 volts). If an over-voltage condition is detected, a motor shutdown is executed that shorts the motor phase windings to prevent regenerated power from flowing into the power supply input which boosts the supply voltage. After motor shutdown, the **Kill Motor Recovery** routine is called allowing a recovery program to detect and/or correct the error. If the motor driver is enabled while the voltage is above the trip point, the motor will again be shutdown and the **Kill Motor Recovery** routine will be called again. The presence of an over voltage trip indicates the need for a power clamp module to dissipate the power generated during high decelerations/braking operations.

NOTE: The **Kill Enable Driver** command does not allow the motor driver to stay enabled when an **Over Voltage Trip** occurs. This condition always disables the motor driver.

The motor driver is disabled when this condition occurs and must be re-enabled using the **Enable Motor Driver** command or by re-writing the **Motor Constants**.

The factory default is set at 53 volts. A power supply voltage that exceeds 52 volts may cause the motor to shutdown at power up. Unregulated power supplies with excessive voltage ripple can cause an over voltage trip, even though an average reading meter may report the voltage as within specification. The over voltage trip may also activate when doing rapid decelerations with large inertias, or using the SilverMax as a clutch without using a **Clamp Module** between the SilverMax and the power supply.

Note: the over voltage and low voltage thresholds are dependent upon the CAL ADC command having been executed to retrieve the ADC calibration factor from a factory non-volatile memory location.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Over Voltage Trip (OVT)	Program (Class "D")	213 (0xD5)	<Voltage>	1 to 53 (1 to 0x35)

Example:

Shut down the Motor if the input voltage exceeds 51 volts

@16 212 51 (CR)

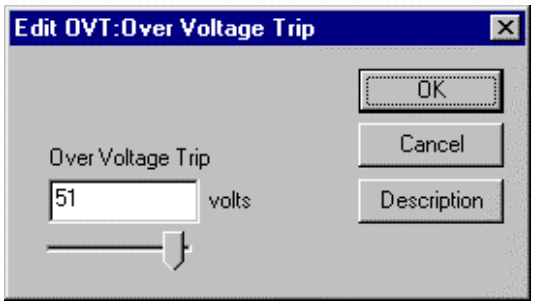
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PHASE ADVANCE CONSTANTS (PAC)

Description:

Sets the motor phase advance constants. These are motor type and power supply voltage dependent to optimize motor torque at high speed. Factory set for optimal performance.

The parameters for this command must be obtained from the factory. Normally these are set using the **Initialize SilverMax** tool in the **QuickControl** software. (See "**Initialization**" in the **SilverMax User Manual** for more information on SilverMax motor initialization.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Phase Advance Constants (PAC)	Program (Class "D")	172 (0xAC) [4 Words]	< P_adv >	0 to 15 (0 to 0x0F)
			< P2_adv >	0 to 600 (0 to 0x0258)
			< P_limit >	0 to 37 (0 to 0x25)

Example:

Phase advance for a 23-5 SilverMax

@16 172 5 160 37 (CR)

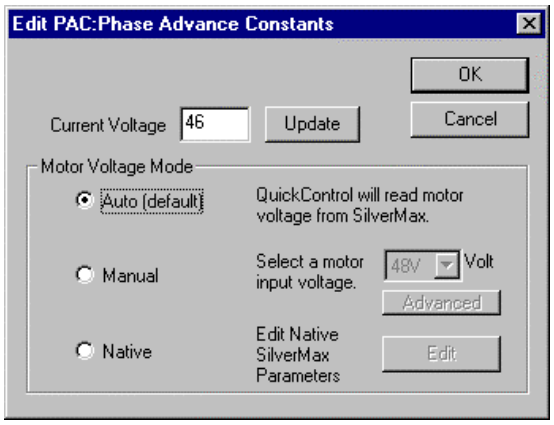
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



POWER LOW RECOVERY (PLR)

See Also: **LOW VOLTAGE TRIP (LVT)**

Description:

This command designates which routine from non-volatile memory to run if the power supply voltage drops below that specified by see **Low Voltage Trip.** A value of zero indicates to shut down the motion and then to do nothing.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Power Low Recovery (PLR)	Program (Class "D")	208 (0xD0) [2 words]	<Process>	0 = Do Nothing -1 = Restart 1 to 3839 = NV Memory address (1 to 0x0EFF)

Example:

If power low condition exists Load and Run Program at 200

@16 208 200 (CR)

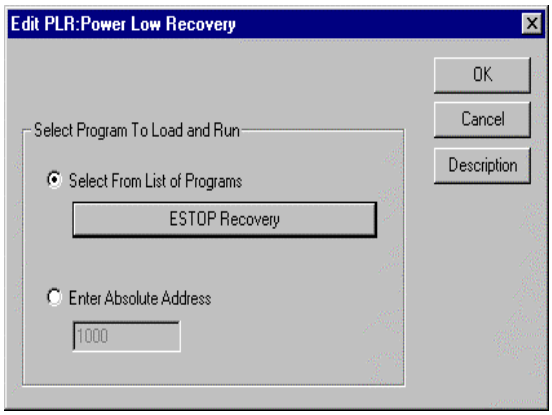
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PROTOCOL (PRO)

Description:

Allows the user to select the desired communications protocol. Two different protocols are available: the 8-Bit ASCII and the 9-Bit Binary. In the power up **Initialization Program**, one of the two protocols should be selected. (See **SilverMax User Manual** for more information on Protocols.)

At power up and before the Initialization Program is executed, SilverMax is first set to the 9-Bit Binary protocol for 120 milliseconds, then switches to the 8-Bit protocol for 120 milliseconds. Also during this time the Baud Rate is set to 57600 and the Serial Interface is RS-485, and then RS-232. This power up procedure allows a **Host Controller** to get access to the SilverMax without knowing what protocol, Baud Rate or serial hardware is selected in the Initialization Program.

A **Halt** command can be sent repeatedly during power up. When SilverMax recognizes the command it will Halt and remain in the mode it was in at the point the **Halt** command was received. From this point the SilverMax is now in a known state and can be initialized to the desired settings.

Note: The unit will usually recognize RS-232 levels even when in RS-485 mode, although it can not properly respond. If operating in RS-232 mode, explicitly command the motor to this mode if the power on routine has been stopped via a Halt command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Protocol (PRO)	Program (Class “D”)	185 (0xB9) [2 Words]	<Selection>	0 = 9-Bit 1 = 8-Bit (Default)

Example:

Select the 8-Bit ASCII Protocol

@16 185 1 (CR)

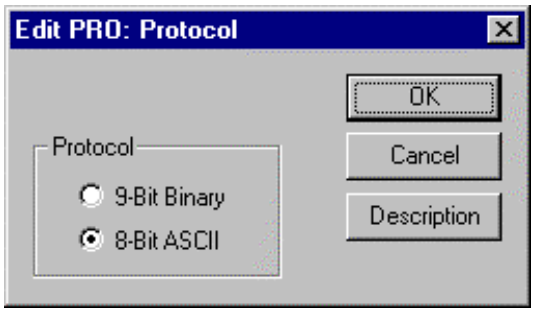
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



S-CURVE FACTOR (SCF)

See Also: **Motion Profile Commands**

Description:

Using this command, the shape of motion profile acceleration can be set from **Linear** to full **S-curve**. All motion profile commands use the current setting. This command can be set at any time (except for during a motion) allowing each motion profile to be tailored for the best shape.

S-Curves are not available in the **Step & Direction, Profiled Move, Input Mode** or the **Velocity** modes.

S-Curve factor will affect the **Acceleration Time** in all the **Velocity Based** and **Time Based** motion profile commands. When using a "Full S-Curve" factor (32767), the **Acceleration** value will need to be multiplied by two to get the same acceleration time. **Acceleration** in the motion profile command is a maximum value. S-Curves require a higher maximum acceleration in the middle of the curve than a linear acceleration. In time based moves, the Acceleration time and motion time will be honored, but the peak motor acceleration will be increased as the S-Curve factor is increased.

(See **SilverMax User Manual** for more information on S-Curve usage in Motion Profiles.)

Command Info:

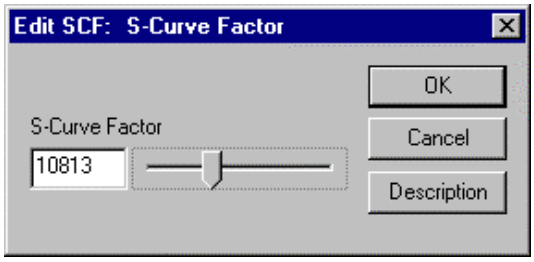
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
S-Curve Factor (SCF)	Program (Class "D")	195 (0xC3) [2 Words]	<Curve Shape>	0 = Trapezoidal 1 to 32766 = "S" Shape 32767 = Full "S" Default = 0

Example:

Use some S-Curve on next Motion Profile

@16 195 10813 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR**)

SELECT EXTERNAL ENCODER (SEE)

See Also: **SCALED STEP & DIRECTION (SSD)**

Description:

Selects the desired input format for an external encoder or step/direction input. External encoders can be used by the "Step and Direction" commands, as well as the Dual Loop mode . If an external encoder is not being used, the inputs are ignored. The count since cleared or powered up is available in the register 200 - "External Encoder". A sensing of the designated index source causes the external encoder counter contents to be copied to register 201 - external encoder index. SEE does not tri-state the selected inputs. If an I/O is already set LOW or HIGH it will remain that way after the SEE command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Select External Encoder (SEE)	Program (Class "D")	192 (0xC3) [4 Words]	<Index State>	0 = Falling (Default) 1= Rising
			<Index Source>	0 = I/O #6 (Default) 1 = I/O #2
			<Encoder Style>	0 = A/B Quad 1 = Step Up/Dn 2 = Step & Dir 3 = Use I/O 2 & 3 (Default)

Example:

Set up the External encoder inputs for Falling edge, Index on input #6 and Step & Dir on #2 & #3.

@16 192 0 0 3 (CR)

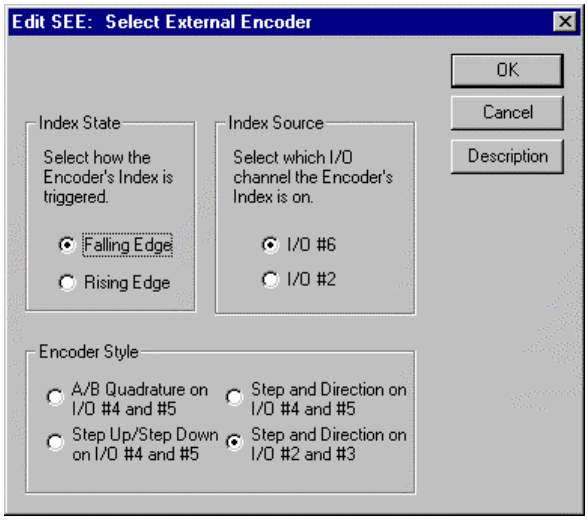
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:


Edit SEE: Select External Encoder
OK
Cancel
Description
Index State
Select how the Encoder's Index is triggered.
Falling Edge
Rising Edge
Index Source
Select which I/O channel the Encoder's Index is on.
I/O #6
I/O #2
Encoder Style
A/B Quadrature on I/O #4 and #5
Step and Direction on I/O #4 and #5
Step Up/Step Down on I/O #4 and #5
Step and Direction on I/O #2 and #3

SERIAL INTERFACE (SIF)

Description:

Allows the user to select between RS-232 and RS-485 serial communications hardware interface. RS-485 is default. This command is usually used at power up as part of the initialization program. Care should be taken when using this command, as communications may be lost if the Host Controller is not compatible with the new hardware setting.

At power up and before the Initialization Program is executed, the SilverMax **Serial Interface** is set to RS-485. A controller using an RS-232 interface will be able to send commands to the motor but will not be able to receive a response. RS-232 can transmit to RS-485 but cannot receive from RS-485. The **Serial Interface** can be set to the proper setting using this command no matter which is used by the Host Controller.

(See **SilverMax User Manual** for more information on using RS-232 or RS-485 on SilverMax.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Serial Interface (SIF)	Program (Class "D")	186 (0xBA) [2 Words]	<Selection>	0 = RS232 1 = RS485 (Default)

Example:

Set up SilverMax to use RS-232 for the serial interface

@16 186 0 (CR)

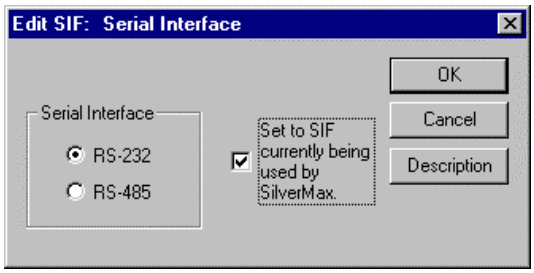
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



SINGLE LOOP CONTROL (SLC)

See Also: **SELECT EXTERNAL ENCODER (SEE), DUAL LOOP CONTROL (DLC)**

Description:

Configures SilverMax to run in the standard "Single Loop" control mode. All SilverMax encoder information for commutation, position, velocity and acceleration control is derived from the **Internal Encoder**.

If a motion is running, the motor **Trajectory Generator** must be shut down prior to executing this command or a sequence error will result.

When entering Single loop control SilverMax sets the current "Target" to the "Current position" (Internal Position from the **Internal Encoder**).

By default, SilverMax starts up in **Single Loop Control** mode.

See the **Dual Control Loop** command for cases where **External Encoder** position control is required. Switching between Single Loop and Dual Loop modes usually requires changing the control loop tuning. See notes on **Dual Loop Control**.

Command Info:

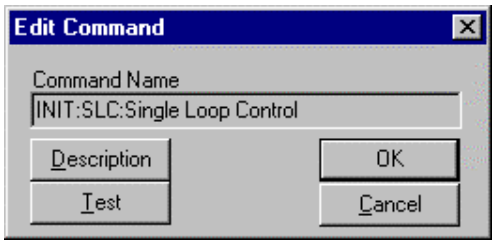
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Single Loop Control (SLC)	Program (Class "D")	244 (0xF4) [1 Words]	NONE	NONE

Example:

Configure SilverMax for Single Loop Control

@16 244 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

SOFT STOP LIMITS (SSL)

See Also: **WRITE REGISTER, PROGRAM TYPE (WRP) & Write Register, Immediate type (WRI)**

Description:

Sets position limits for "End of Travel" control. Two **Data Registers** are used to store the end limits. End of travel positions must be stored in the specified Registers using a **Write Register** command. The **Data Register** selection sets aside two registers in succession. Any motion affecting the Target is limited so as to keep the target more than the first register value and less than the second register value. If the target is beyond a limit, only motion in the direction toward the limit is allowed. The motion exceeding a given limit is hard stopped at the point that the limit is encountered – no ramping occurs. Internally, the motion calculations continue, but their effect is not directed to the Target value.

The **Data Registers** can be set with limit values ranging from -2,147,483,647 to +2,147,483,647. This is the full positional range of the SilverMax. The limits consider the position as "Linear" rather than "Cyclic". If the position attempts to wrap-around (going past the full range values), the **Soft Stop Limits** will prevent this movement.

The **First Data Register** is used for the **Lower Limit**, which is checked when the distance of the move is negative. The **Second Data Register** is used for the **Upper Limit**, which is checked when the distance is positive. The **Absolute** commands always calculate a **Distance** value before the move begins so even though the absolute value may be positive it may dictate a negative distance.

If the **Lower Limit** is set more positive than the **Upper Limit**, this will create a **Dead Zone**. If the motor's position is in the **Dead Zone**, it will not be able to move. No error checking is done on the **Data Register** values to prevent this condition.

If the limits are set so that the Target is outside of the permitted range, only motions toward the permitted range are effective. Drag mode may allow the Target to be forced outside the permitted range if manually moved. Again, only motions that move toward or within the permitted range will have effect.

Command Info:

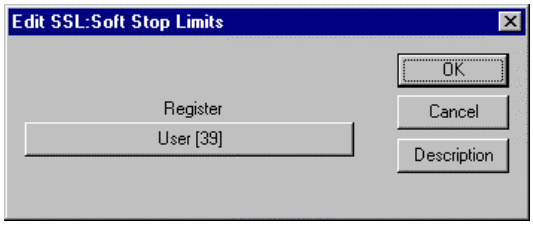
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Soft Stop Limits (SSL)	Program (Class "D")	221 (0xDD) [2 Words]	<Data Register> (First of two)	0 = Not Used 10 to 39

Example:

SilverMax uses Data Registers 39 & 40 for end a travel position limits

@16 221 39 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

TORQUE LIMITS (TQL)

See Also: **ERROR LIMITS (ERL) & ANTI-HUNT CONSTANTS (AHC)**

Description:

This command sets the torque limits for the different operating modes of the SilverMax unit. The unit may be in either **Open Loop** or **Closed Loop mode**, and in either **Moving** or **Holding** position. The four parameters supplied set the limits on the output torque for all four combinations: **Closed Loop Holding**, **Closed Loop Moving**, **Open Loop Holding**, and **Open Loop Moving**. The motor goes into **Moving** mode whenever the target velocity is non-zero. The unit will continue to use the **Moving** torque limits until **Delay to Holding** time ticks (120uS each) (see **Error Limits** command) after the last non-zero target velocity. This allows a higher **Moving** torque limit to persist up to seven seconds after the last motion (or motion step of the **Step and Direction** command). Following this period (which power up defaults to zero), the **Holding** torque levels are used.

The **Open Loop Holding** value is used by the **Anti-Hunt** mode for the current level that will be used to prevent hunting. This is only used when the **ANTI-HUNT CONSTANTS** are set to a value greater than "0".

17 and 23 frame motors have a 100% torque level corresponding to 20,000, while the various 34 frame motors may have different full scale values. The QuickControl **Torque Limits** command tool automatically scales percentage values to numeric values for all motor types. Peak torques above 100% are permitted, but at a reduced duty cycle and duration.

The setting for the **Closed Loop** parameters establishes the maximum torque limit within the control loop, but the motor current (and thus heat) will only be what is needed to generate the required torque. The **Open Loop** parameters, on the other hand, will cause the respective motor current (and heat) regardless of load. For most operations, the open loop parameters should be set to 50% or less to minimize motor heating; these are only used if the anti-hunt mode is enabled or the Open Loop Mode is selected.

To determine the actual maximum torque that may be applied to the load, refer to the **Torque Curve Charts** in found in the **QuickSilver Controls Product Catalog**. The 100% torque applied to the load depends on the speed of operation. 100% torque at stall may be 100 oz-in while the 100% torque at 2000 RPM may be 50 oz-in (data from 23H-3 Torque Curve).

This applies to reading back the **Torque Value** from **Data Register #9**. The value read back must be compared to the **Current Velocity** of the motor and the **Torque Curve** to calculate the **Actual Torque** being required of the motor. If, for example, the value being read back was 5000 and the motor was running at 2000 RPM the torque being required of the motor is actually 50 oz-in / (20000/5000) which equals 12.5 oz-in.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Torque Limits (TQL)	Program (Class "D")	149 (0x95) [5 Words]	<Closed Loop Holding>	0 to 32767 (0 to 0x7FFF)
			<Closed Loop Moving>	0 to 32767 (0 to 0x7FFF)
			<Open Loop Holding>	0 to 32767 (0 to 0x7FFF)
			<Open Loop Moving>	0 to 32767 (0 to 0x7FFF)

Torque parameter range changes depending on motor type. Use the following table to determine the range for your SilverMax™.

SilverMax™ P/N	100% Torque	Max Torque
Any 17 or 23	20000	30000
34N-1	20000	30000
34H-1	16383	24575
34H-2	16383	24575
34H-3	14745	14745
34H-4	10619	22117
34HC-2	20000	30000

Example:

Set torque to:
Closed Loop Holding 75%
Closed Loop Moving 100%
Closed Loop Holding 50%
Closed Loop Moving Max

@16 149 15000 20000 10000 30000(CR)

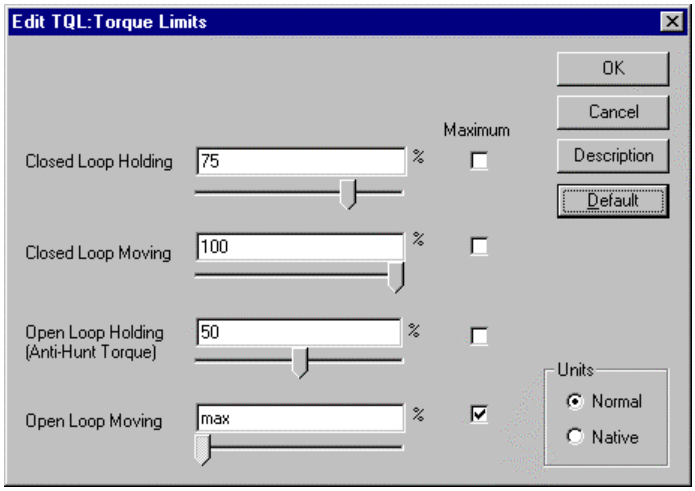
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



TORQUE RAMP UP (TRU)

Description:

Ramps up the torque limit values by the increment given up to the final value. This is used mainly during motor initialization. Only Ramps up **Open Loop Torque Limits**. This command slowly brings up the **Open Loop** motor current to avoid a harsh or sudden movement during motor power up. This is done just prior to the algorithmic alignment of the motor rotor to the encoder. The increment sets how much current will be added each servo cycle (120usec).

The ramp up time is calculated by taking the **final value** divided by the **increment** times 120usec.

Example:

20000/5 = 4000
4000 * 0.00012 = 480 milliseconds

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Torque Ramp Up (TRU)	Program (Class "D")	222 (0xDE) [3 Words]	<final value>	0 to 32767
			<increment> per 120usec	1 to 32767

Example:

Set open loop current to 20000 (100%) in 4000 servo cycles (480 milliseconds)

@16 222 20000 5(CR)

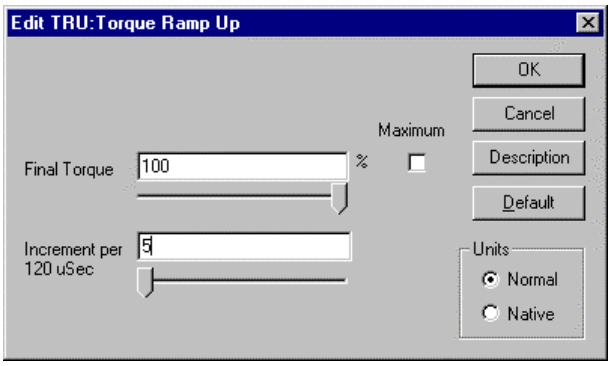
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Mode Commands

Mode Commands put SilverMax into required and special modes of operation. Some modes give SilverMax the ability to input analog or Step and Direction signals for motion control.

GO CLOSED LOOP (GCL)

Description:

Puts SilverMax into **Closed Loop** operation. This is typically only done one time during initialization. This command is used to put SilverMax into **Closed Loop** mode if the unit has been placed into **Open Loop** Mode. This command sets the phase relationship between the motor rotor and the encoder for closed loop operation. (See **SilverMax Initialization** in the **SilverMax User Manual** for more information.)

The motor will not go into **Closed Loop** mode if the motor is moving as indicated by an encoder count of greater than 1 during a 100 milliseconds period. The motor must be stationary when going into **Closed Loop** mode to prevent improper phase alignment of the motor rotor to the encoder.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Go Closed Loop (GCL)	Program (Class "D")	142 (0x8E) [1 Word]	NONE	NONE

Example:

Put SilverMax into closed loop mode

@16 142 (CR)

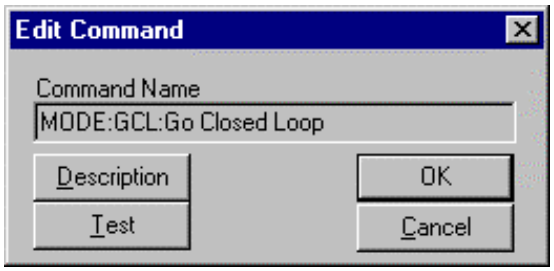
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



GO OPEN LOOP (GOL)

Description:

Puts SilverMax into open loop operation. This is the default motor power up mode. This command is used during motor initialization to aid in aligning the motor rotor to the encoder (See **SilverMax Initialization** in the **SilverMax User Manual** for more information.)

The command can also be used to force the motor into **Open Loop** mode where it can be operated in a Stepping Motor drive mode. This is not recommended for normal operation, as the motor performance is severely degraded.

If the motor is in **Dual Loop Control** operation when this command is encountered, it is forced back into **Single Loop Control**.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Go Open Loop (GOL)	Program (Class "D")	143 (0x8F) [1 Word]	NONE	NONE

Example:

Put SilverMax into open loop mode

@16 143 (CR)

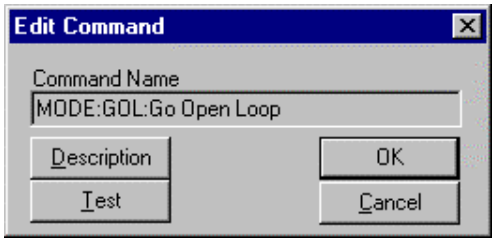
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



POSITION INPUT MODE (PIM)

See Also: **Input Mode Usage** below

Description:

Puts the SilverMax into a **Position** control mode. Uses the contents of **Data Registers #12 -18** for position control processing. The **Position Input Mode** may be exited via I/O by configuring the I/O Exit State and enable. As with other motions, **the Position Input Mode** may also be exited via the **Stop** command, the **Change Velocity Program**, and the **Profiled Move Exit** command.

In this mode, data from an **Analog Input** or the **Serial Interface** can be used to control the position of the motor. A filter parameter is used to filter the incoming data. See "**Filter Parameters**" at the beginning of this manual for details in converting Hz to native SilverMax values. The QuickControl tool allows this parameter to be set by frequency. This is the same type of low-pass filter as used in the **Velocity Estimator** filters (in the PVIA loop).

Digital inputs are used in the same manner as the **Motion Profile Commands** (See **Using Inputs to Stop Motions** in the **SilverMax User Manual.**)

Position Input Mode uses a set of **Data Registers** and processing to allow sophisticated manipulation of the input data. This allows the input signal to be calibrated to give the desired position control (see **Input Mode Usage** for more details on using this mode).

Before putting SilverMax into the **Position Input Mode**, **Data Registers #12-18** must be initialized with the appropriate data to allow proper operation. If using an Analog input for the data source, the Analog channel to be used must be set up for continuous reading before issuing the mode command (see **Analog Continuous Read** command).

Command Info:

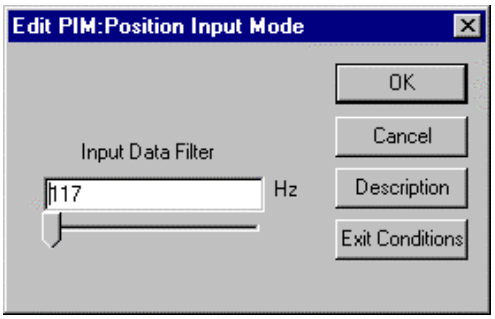
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Position Input Mode (Pim) (Actually Target input)	Program (Class "D")	216 (0xD8) [4 Words]	<Filter constant>	0 to 32767 (0 to 0x7FFF)
			<Stop Enable>	0 to 65535 {–1 to –7} (0 to 0xFFFF)
			<Stop State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)

Example:

Position Input mode using a 117 Hz filter.

$30000 = 32768\ e^{-(117)2\pi(120uS)}$

@16 216 30000 0 0 (CR)



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:

REGISTERED STEP & DIRECTION (RSD)

See Also: **SCALED STEP & DIRECTION (SSD)**

Description:

This command works the same as the **Scaled Step and Direction** command below except that the "scaling" value is found in a **User Data Register** specified in the parameter.

The scaling value should be stored in the **User Data Register** prior to executing this command, but it may be modified at any time after the **Step and Direction mode** is initiated. All commands able to modify **Data Register** contents can be used to set the scaling value. This includes the **Calculation** command, which can be used to dynamically adjust the scaling value when in **Multi-Tasking** operation.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Registered Step & Direction (RSD)	Program (Class "D")	223 (0xDF) [2 Words]	<User Data Register>	10 to 40 (0x0A to 0x28)

Example:

Put SilverMax into a Set & Direction mode using User Data Register #11 for the scaling value

@16 223 11 (CR)

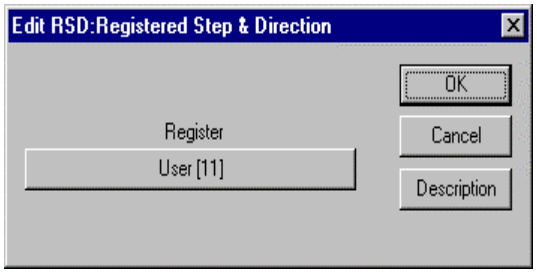
SilverMax Response:

ACK only

Response Example:

***10 (CR)**

QuickControl Example:



SCALED STEP & DIRECTION (SSD)

See Also: **SELECT EXTERNAL ENCODER (SEE)**

Description:

The **Scaled Step and Direction** command causes the system to exit the **Hold** mode of operation and follow a counter as a **Target Position**. The **Target Position** and **Target Velocity** are controlled by the **Step and Direction Input**. These are TTL Level and should be optically isolated from any other grounds in the system. The local +5v supply (provided by the SilverMax unit through the connector) may be used to power the local side of the optical coupler.

The **Step and Direction inputs** can be configured to accept one of three different types of signals. Inputs can be **A & B Quadrature**, **Step & Direction** or **Step Up & Step Down**. The type of input is configured using the **Select External Encoder** command. Step inputs can accept a minimum pulse width of 400 nanoseconds. (See **Step & Direction Input** in the **SilverMax User Manual** for more information on digital inputs.)

Scale Factor: The maximum positive value of 32767 is approximately 32 encoder counts per Step clock (32767/1024), the minimum value is 1 encoder count of motion for 1024 *Step* pulses. A value of 1024 gives a 1 to 1 factor (1 Step equals 1 Count). A negative value for the scaling factor reverses the state of the **Direction Input** (this is so that no external logic is required to invert the **Direction input**).

The Step and Direction inputs drive a counter, which is sampled every 120uS. The counts detected are scaled and summed to any remaining fractional count left from the prior period, with the whole count being applied to the **Target Position** value. The fractional remainder is saved for the following period. Counts in excess of the maximum (+31, -32) counts per sample period are accumulated for use in the following sample period to handle sample period to sample period variations. The excess sample counts should not be allowed to exceed 1024 counts to prevent loss of counts.

The counter is also double low pass filtered to generate an estimate of the **Target Velocity** for the **Velocity Feedforward** term. The filter time constants used are the same as is used for the **Velocity #1** and **Velociy#2 Filters** in the feedback loop. All of the filter time constants in the system are set by the **Filter Constants** command. The system switches to **Moving Torque** and **Error Limits** checking upon the first Step pulse being received, and remains with these settings until the **Hold Delay** time has passed since the last **Step** pulse has been received and since the **Target Velocity** filter has been allowed to decay to zero. Once these time limits have elapsed, the system reverts to **Holding Torque** limits and **Holding Error** limits.

As with other moves, the **Scaled Step and Direction** move may be exited via the **Stop** command, or by the **Change Velocity Program**, and the **Profiled Move Exit** command if multitasking is enabled.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Scaled Step & Direction (SSD)	Program (Class "D")	180 (0xB4) [2 Words]	<Scale Factor>	1 to 32767 (1 to 0x7FFF) 1024 is a multiplier of 1

Example:

Put SilverMax into a Step & Direction mode with a step multiplier of 1

@16 180 1024 (CR)

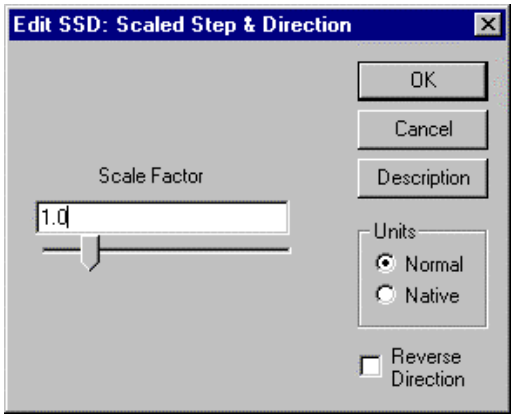
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



TORQUE INPUT MODE (TIM)

Description:

Puts the SilverMax into a **Torque** control mode. Uses the contents of **Data Registers #12 -18** for torque control processing while the motor is moving.

In this mode, data from an **Analog Input** or the **Serial Interface** can be used to control the torque of the motor while moving. A filter parameter is use to filter the incoming data. See "**Filter Parameters**" at the beginning of this manual for details in converting Hz to native SilverMax values. This is the same type of low-pass filter as used in the **Velocity Estimator** filters (in the PVIA loop).

The **Torque Input Mode** may be exited using digital inputs. Digital inputs are used in the same manner as the **Motion Profile Commands**. (See "**Using Inputs to Stop Motions**" in the **SilverMax User Manual.**) As with other motions, **the Torque Input Mode** may also be exited via the **Stop** command, or the **Change Velocity Program**, and the **Profiled Move Exit** command if multitasking is enabled.

Torque Input Mode uses a set of **Data Registers** and processing to allow sophisticated manipulation of the input data. This allows the input signal to be "calibrated" to give the desired torque control. (See **Input Mode Usage** for more details on using this mode).

Before putting SilverMax into the **Torque Input Mode**, **Data Registers #12-18** must be initialized with the appropriate data to allow proper operation. If using an Analog input for the data source, the Analog channel to be used must be set up for continuous reading before issuing the mode command. (See **Analog Continuous Read** command)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Torque Input Mode (TIM)	Program (Class "D")	218 (0xDA) [4 Words]	<Filter constant>	0 to 32767 (0 to 0x7FFF)
			<I/O Exit Enable>	0 to 65535 {–1 to –7} (0 to 0xFFFF)
			<I/O Exit State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)

Example:

Torque Input mode using a 515 Hz filter.
Exit if Input #1 is high ("1")

$30000 = 32768\ e^{-(117)2\pi(120uS)}$

@16 216 2222 –1 1 (CR)

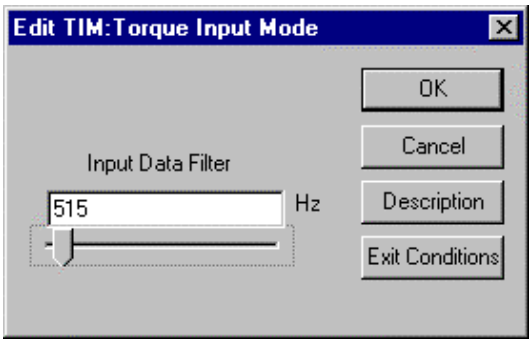
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



VELOCITY INPUT MODE (VIM)

See Also: **Input Mode Usage** below

Description:

Puts the SilverMax into a **Velocity** control mode. Uses the contents of **Data Registers #12 -18** for velocity control processing.

In this mode, data from an **Analog Input** or the **Serial Interface** can be used to control the velocity of the motor. A filter parameter is use to filter the incoming data. See "**Filter Parameters**" at the beginning of this manual for details in converting Hz to native SilverMax values. This is the same type of low-pass filter as is used in the **Velocity Estimator** filters used in the PVIA loop.

The **Velocity Input Mode** can be exited using digital inputs. Digital inputs are used in the same manner as the **Motion Profile Commands**. (See **Using Inputs to Stop Motions** in the **SilverMax User Manual.**) As with other motions, **the Velocity Input Mode** may also be exited via the **Stop** command, or the **Change Velocity Program**, and the **Profiled Move Exit** command if multitasking is enabled.

Velocity Input Mode uses a set of **Data Registers** and processing to allow sophisticated manipulation of the input data. This allows the input signal to be calibrated to give the desired velocity control. (See **Input Mode Usage** for more details on using this mode.)

Before putting SilverMax into the **Velocity Input Mode**, **Data Registers #12-18** must be initialized with the appropriate data to allow proper operation. If using an Analog input for the data source, the Analog channel to be used must be set up for continuous reading before issuing the mode command (see **Analog Continuous Read** command).

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Velocity Input Mode (VIM)	Program (Class "D")	217 (0xD9) [4 Words]	<Filter constant>	0 to 32767 (0 to 0x7FFF)
			<I/O Exit Enable>	0 to 65535 {–1 to –7} (0 to 0xFFFF)
			<I/O Exit State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)

Example:

Velocity Input Mode using a 117 Hz filter.

$30000 = 32768\ e^{-(117)2\pi(120uS)}$

@16 217 30000 –1 1 (CR)

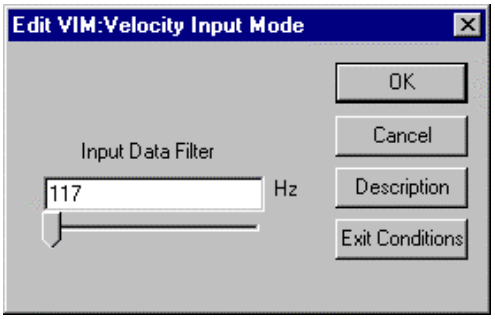
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



INPUT MODE USAGE (IMU)

Input mode is designed to use **Data Registers** for processing **Position**, **Velocity** or **Torque** information for the given modes. This allows SilverMax to input data from an **Analog Input** or the **Serial Interface** for operating in the selected modes.

The **Data Registers** are used to perform processing on the input data so that the output will give the desired results. If, for example, the input is an analog data source from a Joystick the processing can serve to calibrate the Joystick for the desired motion on the SilverMax. This can be done for almost any kind of data source including data which is sent through the **Serial Interface.**

All Input mode commands use the same dedicated **Data Registers** for data storage and manipulation. When SilverMax is placed into one of the input modes (Velocity, Position or Torque) 7 data registers starting at #12 are automatically assigned for use in the data processing.

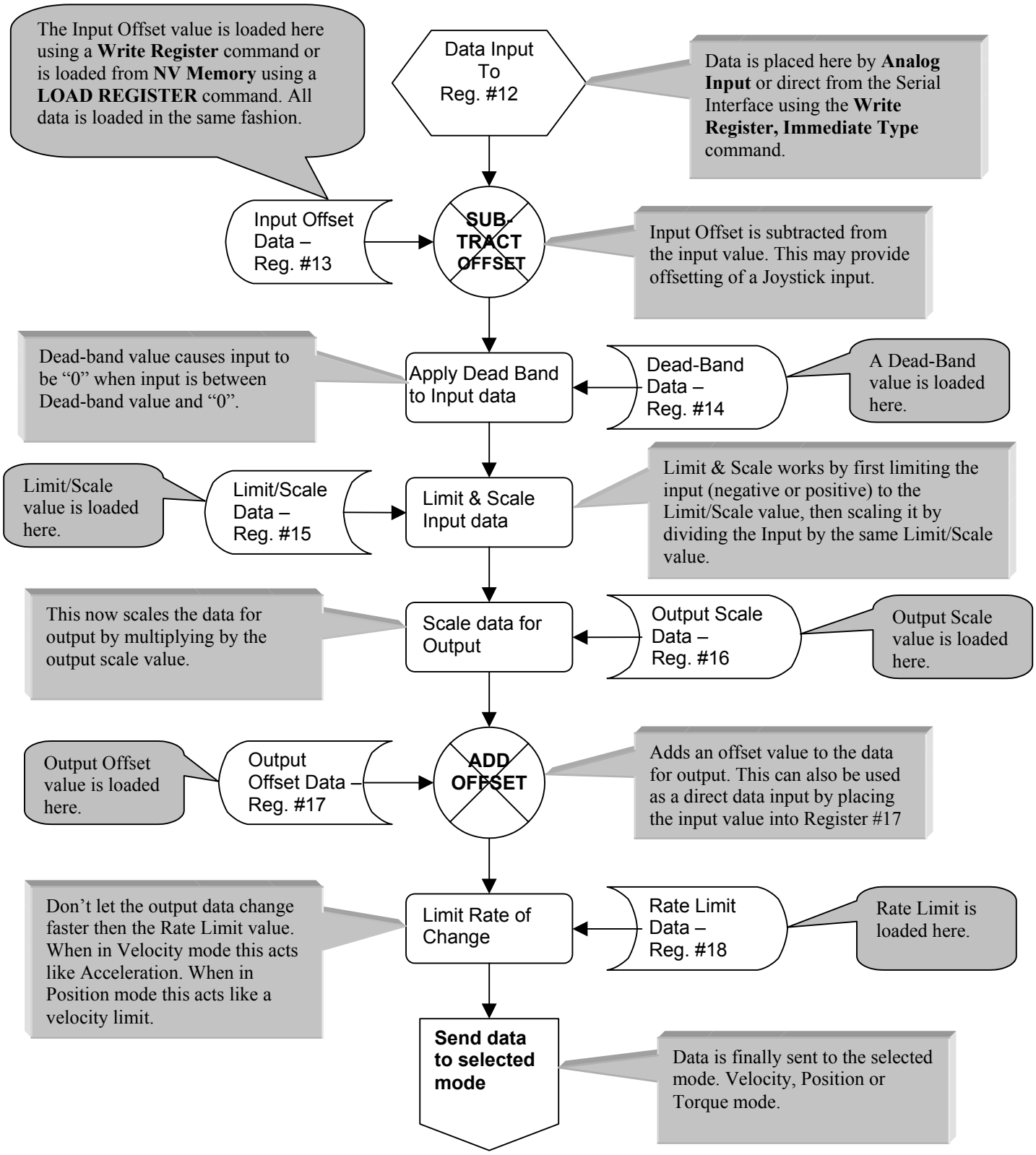
The appropriate **Data Registers** must be initialized before the input modes will work properly, though they may be dynamically changed while the mode is operating. This may be done in two different ways. The **Data Registers** may be initialized using **the Serial Interface** by sending data directly to the registers using the **Write Register, Immediate type** command. This method requires that a **Host** controller be connected to the **Serial Interface** during initialization. Another method is to use data that has been previously stored in the **Non-volatile memory**. Using the **Register Load Multiple** command all of the Data Registers may be initialized at one time. The **Register Load from Non-Volatile** can also be used, but it requires each register to be loaded one at a time. If the register load method is used the data must be stored in **Non-Volatile Memory** ahead of time using either the **Register Store Multiple** or the **Register Store to Non-Volatile** commands. The **Write Register Program** command may also be used to initialize these registers within a program.

The following is a description of the **Data Registers** used and their functions.

Data Register #	Data Range	Data Source	Data Register Function
#12	-2,147,483,648 to +2,147,483,647	SilverMax or User	Input Source Data – Data can be placed here by Analog or Data Register commands.
#13	-2,147,483,648 to +2,147,483,647	User	Input Offset
#14	0 to 32767	User	Input Dead band
#15	0 to 32767	User	Maximum Scale/Limit
#16	-2,147,483,648 to +2,147,483,647	User	Maximum Output Scale
#17	-2,147,483,648 to +2,147,483,647	User or SilverMax	Output Offset
#18	0 to +2,147,483,647	User	Output Rate of Change Limit

The following diagram shows the Data, Operations and data flow used for the **Input Modes**.

Input Mode Data Processing Diagram


The Input Offset value is loaded here using a **Write Register** command or is loaded from **NV Memory** using a **LOAD REGISTER** command. All data is loaded in the same fashion.
Data Input To Reg. #12
Data is placed here by **Analog Input** or direct from the Serial Interface using the **Write Register, Immediate Type** command.
Input Offset Data – Reg. #13
SUB-TRACT OFFSET
Input Offset is subtracted from the input value. This may provide offsetting of a Joystick input.
Dead-band value causes input to be "0" when input is between Dead-band value and "0".
Apply Dead Band to Input data
Dead-Band Data – Reg. #14
A Dead-Band value is loaded here.
Limit/Scale value is loaded here.
Limit/Scale Data – Reg. #15
Limit & Scale Input data
Limit & Scale works by first limiting the input (negative or positive) to the Limit/Scale value, then scaling it by dividing the Input by the same Limit/Scale value.
This now scales the data for output by multiplying by the output scale value.
Scale data for Output
Output Scale Data – Reg. #16
Output Scale value is loaded here.
Output Offset value is loaded here.
Output Offset Data – Reg. #17
ADD OFFSET
Adds an offset value to the data for output. This can also be used as a direct data input by placing the input value into Register #17
Don't let the output data change faster then the Rate Limit value. When in Velocity mode this acts like Acceleration. When in Position mode this acts like a velocity limit.
Limit Rate of Change
Rate Limit Data – Reg. #18
Rate Limit is loaded here.
Send data to selected mode
Data is finally sent to the selected mode. Velocity, Position or Torque mode.

Velocity Mode, Immediate Type (VMI)

Description:

Accelerates the motor from the present velocity to the indicated velocity using the given acceleration. If the motor has an active move operation in progress, that motion is taken over from its current velocity, and motor ramps to the new velocity at the given acceleration rate. Any program operating is stopped and the contents of the command buffer are modified. This command is used when the velocity mode needs to be controlled from a Host controller. This command can only be used through the serial interface. See the **Velocity Mode, Program Type** command below for embedding in a program.

NOTE: If the acceleration is negative, any accumulated position error is removed and the absolute value of the acceleration is then used.

This command is ended either by use of the Stop enable and Stop state which cause the velocity to ramp to zero at the acceleration rate, or by selecting a velocity of zero when the command is issued. As with other motions, the **Velocity Mode** may also be exited via the **Stop** command, or the **Change Velocity Program**, and the **Profiled Move Exit** command if multitasking is enabled.

See "Scaling" in the beginning of the manual for details on scaling the parameters to engineering units.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Velocity Mode, Immediate Type (VMI)	Immediate (Class "A")	15 (0xF)	<< Acceleration >>	-1 to -1,073,741,823 or 1 to 1,073,741,823
			<< Velocity >>	-2,147,483,647 to +2,147,483,647
			< Stop Enable >	0 to 65,535 (0 to 0xFFFF)
			< Stop State >	0 to 65,535 (0 to 0xFFFF)

Example:

Put SilverMax into velocity mode running at 200 RPM.

@16 15 200000 107374200 0 0(CR)

QuickControl Example:

Immediate (Host) Mode Command Only

See pages 11-12 for details.

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

VELOCITY MODE, PROGRAM TYPE (VMP)

Description:

Accelerates the motor to the indicated velocity using the given acceleration. This command may be run from within a program. When this command is executed in a program, the motion will continue until the velocity reaches zero. Issuing the command with a non-zero velocity and stop on I/O enabled will allow the motor to run at velocity until the selected stop configuration is met; the velocity then ramps down to zero and the motion ends . This command can also be used through the serial interface, however a **NAK BUSY** will be reported when a Program or a motion command is executing. See the **VELOCITY MODE, IMMEDIATE TYPE** command above for velocity mode using the serial interface. If multitasking is enabled, this command will take over any executing motion with out the completion of that motion, and may be used to shutdown a motion is the new velocity is zero.

NOTE: If the acceleration is negative, the accumulated position error is removed and the absolute value of the acceleration is used.

See "Scaling" in the beginning of the manual for details on scaling the parameters to engineering units.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Velocity Mode, Program Type (VMP)	Program (Class "D")	159 (0x9F) [7 Words]	<< Acceleration >>	-1 to -1,073,741,823 or 1 to 1,073,741,823
			<< Velocity >>	-2,147,483,647 to +2,147,483,647
			< Stop Enable >	0 to 65,535 (0 to 0xFFFF)
			< Stop State >	0 to 65,535 (0 to 0xFFFF)

Example:

Put SilverMax into velocity mode running at 200 RPM. See **Scaling**.

@16 159 200000 107374200 0 0(CR)

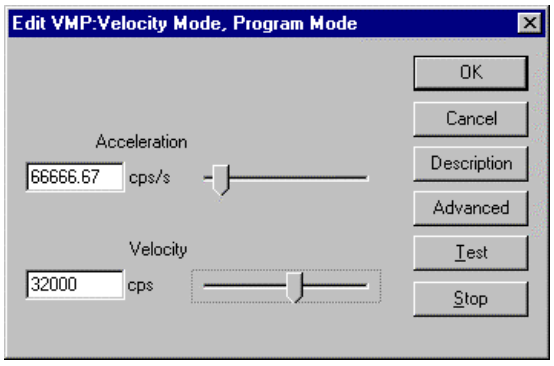
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Motion & Profile Move Commands

Motion & Profile Move commands make up the set of commands that use the SilverMax **Trajectory Generator** to perform simple or complex motions.

Motion & Profile Move Commands

See Also: **S-CURVE FACTOR (SCF)** for all motion profile

Motion & Profile Move commands make up the set of commands that use the SilverMax **Trajectory Generator** to perform simple or complex motions.

Motion commands provide a basic "Acceleration - Velocity - Deceleration" (Trapezoidal) shaped move that goes a given Relative Distance or to a defined Absolute Position. Once initiated these moves cannot be altered dynamically. They may, however be exited via the **Stop** command, or the **Change Velocity Program**, and the **Profiled Move Exit** command if multitasking is enabled.

Motion commands come in three flavors:

1. **Standard**; where all parameters are sent with the command
2. **Registered**; where the **Distance** or **Position** parameters are located in a **User Data Register**
3. **Extended Registered**; where all of the move parameters except for the **Stop Conditions** are located in **User Data Registers**

Within each flavor, there is a matrix of commands that vary the parameter types:

A. **Absolute** or **Relative**
The move runs to a given **Absolute Position** or a **Relative Distance**.

B. **Velocity** or **Time**
The motion profile uses **Acceleration and Velocity** or **Acceleration Time and Total Time** for the speed parameters.

Motion commands can use **Linear** or **S-Curve** acceleration.

Profile Move commands perform very complex profile shapes by allowing the move parameters to be changed dynamically. Move parameters can be changed by an external Host controller or by an internal program if multitasking is enabled. Profile moves also provide separate **Acceleration** and **Deceleration** parameters and a **Distance Offset** when **Stop Conditions** are met.

Profile Move commands come in three flavors:

1. **Standard**; where the command ends when the Distance or Position is reached;
2. **Continuous**; where the command runs continuously until stopped either by the **Stop Conditions** or explicitly.
3. **Override**; where the command will take over *any* active move in progress and continue it according to the parameters established for the Profile move without first stopping the motion. After it has begun its operation, it becomes a Standard Profile move.

All **Profile Move** commands use **User Data Registers** for parameter storage.

Profile Move commands use **ONLY Linear** acceleration and deceleration.

Special Note:

All Velocity and Time based motion commands have a limit of 143.16 hours of total time; the ramp times are limited to 7.86 seconds. To go beyond these limits, the Profile Move commands must be used.

HARD STOP MOVE (HSM)

See Also: **VELOCITY MODE,**
PROGRAM TYPE (VMP)

Description:

This command provides a way, while in **Multi-Tasking** operation, to execute a **Hard Stop** of any move or mode from within a program. A **Hard Stop** immediately halts the **Trajectory Generator** (Motion Commands) or stops the current **Mode** (Step & Direction), in either case the motor will come to an abrupt stop. In many situations, this may cause the motor to overshoot the stop position and oscillate until settled. More controlled stops can be accomplished by using the **Velocity Mode** which allows a user selectable deceleration to "0" velocity (stopped). The **Profile Move End** command may similarly be used to halt an existing motion with a controlled deceleration.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Hard Stop Move (HSM)	Program (Class "D")	229 (0xE5) [1 Word]	NONE	NONE

Example:

Stop the SilverMax immediately.

@16 229 (CR)

SilverMax Response:

ACK only

Response Example:

*** 10 (CR**)

QuickControl Example:

See Also: **Profiled Move (PMV), Interpolated Move Queue Clear(IMQ), Interpolated Move Write (IMW)**

INTERPOLATED MOVE START (IMS)

Description:

This command provides a means generating an arbitrary motion from either **nonvolatile Memory**, or from a host via the Serial Interface. Before issuing this command, Register #17 should be written to point to the source of the profile data, while Register #19 should contain a deceleration value to use if the data stream were to become interrupted. This command takes succeeding sets of 4 data values, and copies them, within a single normal control cycle, into the associated registers used by the profiled move command. It then waits the designated number of cycles (120 microseconds each) before loading the next set of data. At the same time, a Profiled Move operation is running in the background, using the given data. Each set of data represents a timed slice of the total motion, consisting of a constant acceleration period ramping to the new velocity, followed by a constant velocity period until the next set of data is loaded. If the given destination is reachable in the time slice given the other parameters, the target position will come to rest there until the next set of data is loaded that requires the motion to begin again. Complex moves involving multiple axis may be generated that may run from either internal Non volatile memory, or from the Serial interface.

These two distinct modes of operation are selected by the value of the data in Register #17. A non-zero value indicates the address of the first of the four registers that will hold the data. Once this command is executed, the contents of the first of these registers will be copied to Register #18 to be used as a time countdown. The continuing operation of this command will decrement Register #18 each cycle. No external modification of Register #18 should be made while this mode is active.

The second register in this bank of four contains the target position for this time segment. If the segment is intended to end with the velocity non-zero, then this value should be full scale negative if the final velocity is to be negative, or full scale positive if the final velocity is to be positive. If the final velocity of this segment is zero, then the position should be the desired stopping position. This value is automatically copied to Register 20 for use by the profiled move operation.

The third register in this bank of four contains the acceleration or deceleration magnitude (positive values only) for this segment of the move. It is copied to Register # 21 and #23 for use by the profiled move operation.

The fourth register in this bank of four contains the speed (absolute value of the velocity) for this segment of the move. It is automatically copied to Register #22 for use by the profiled move operation.

After the four values have been copied, The upper word of Register #17 is set to “1” to indicate the data has been transferred and is now stale. If updating from internal memory, a multitasking program should be looping until this register has been modified. Next it needs to either point to the next set of data (Register 34, for example) if the data representing the next segment has already been loaded, or it needs to load the data representing the next segment of the move into the same set of Registers, then re-write Register #17 with the starting Register address. If the current movement segment ends while the upper half of Register #17 is non-zero, then the deceleration data in Register #19 is used to decelerate the motion to a stop. An error flag is set in bit 12 of the Status word to indicate a timeout in the data stream. The motion is stopped, but the program continues in operation. The final motion segment of a move is denoted by setting the segment time counter, the data in the first word of the four data words to zero. The final four words of segment information are copied into the respective profiled move operation registers, and the move continues as a profiled move.

This move may also be driven from the Serial Interface. The first method is to initialize the registers, as was explained above, but using the serial interface to write the registers and monitor Register # 17 to determine when the next data needs to be supplied. The preferred method is to use the Interpolated Move Queue Clear and Interpolated Move Write commands. In this mode, the Interpolated Move Clear , a program mode command, is used to clear our any existing data from the a four deep by four long word software FIFO specifically provided for this use. Next , Register #17 is set to zero (0) to indicate data will be drawn from the circular queue. Register #19 should be initialized with an

appropriate deceleration value to use to stop the motion in the case of loss of communications. The Interpolated Start Move command may then be issued. The motion will not start until the first data set has been written to the software FIFO (circular queue). The queue may be kept full by the host via the Serial Interface. The buffering makes it easier to keep one or multiple axis fed with data. It also eliminates an extra register read to determine when data is required. (See **Interpolated Move Write Queue (IMW)** command for details.) The Interpolated move continues until either the Segment Time read is a zero, which terminates as detailed above, or until the queue is found empty when data is required, which uses the deceleration data in Register # 19 to bring the motion to an end, setting error bits as described above.

Please see the Interpolated Move Application Note for more information on converting an arbitrary motion or arbitrary coordinated motions into an Interpolated Move data stream.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Interpolated Move Start (IMS)	Program (Class "D")	253 (0xFD) [1 Word]	NONE	NONE

Register usage:

Register #17 Points to Register containing Segment Data, or "0" for Queued operation.
Register #18 Used internally to hold segment time countdown
Register #19 Holds data loss deceleration value
Registers # 20 to 24, as defined in the **Profiled Move** command **(PMV)**

Note: Register #17 is modified following each non-queued data transfer at the start of each segment. See notes above.

Example:

Start Interpolated Move.

@16 253 (CR)

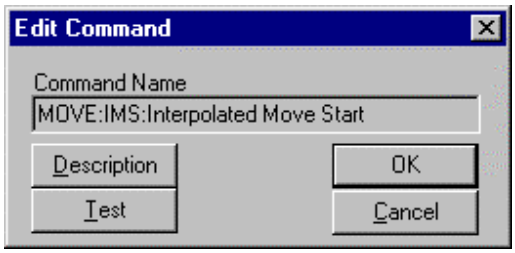
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickContol Example:



SeeAlso: **Profiled Move (PMV), Interpolated Move Start (IMS), Interpolated Move Write (IMW)**

INTERPOLATED MOVE QUEUE CLEAR (IMQ)

Description:

This Command clears any data that may have been left in the Interpolated Move Queue. This queue is a software FIFO (First in first out) buffer capable of holding data for up to four interpolated motion segments, the data for each segment consisting of four long words (32 bits each) of data. If the data is able to fit within the queue, it is accepted and the communication is acknowledged. If the queue is full, the request is answered with a NAK – Full response. This just indicates that the host is successfully keeping the queue filled. The same data should be sent again until it is positively Acknowledged.

Command Info:

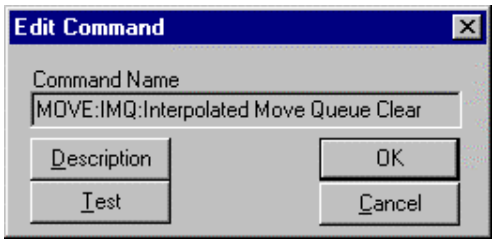
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Interpolated Move Queue Clear (IMQ)	Program (Class "D")	254 (0xFE) [1 Word]	NONE	NONE

Example:

Stop the SilverMax immediately.

@16 254 (CR)

QuickContol Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

See Also: **Profiled Move (PMV), Interpolated Move Start (IMS), Interpolated Move Clear (IMC)**

INTERPOLATED MOVE WRITE QUEUE (IMW)

Description:

This Command writes data to the Interpolated Move Queue through the Serial Interface. This queue is a software FIFO (First in first out) buffer capable of holding data for up to four interpolated motion segments, the data for each segment consisting of four long words (32 bits each) of data. If the data is able to fit within the queue, it is accepted and the communication is acknowledged. If the queue is full, the request is answered with a NAK – Full response. This NAK is to be expected: it just indicates that the host is successfully keeping the queue filled. The same data should be sent again until it is positively Acknowledged.

The four long words of data associated with each Interpolated Move segment are:

1) Time ticks, 0 to 2,147,483,647 indicating the number to 120 microseconds time slices the segment is to last. A "0" indicates it is the last segment of the move.
2) Position –2,147,483,648 to 2,147,483,647. Unless the segment is intended to come to a halt at a given location, this should be full scale positive if the final velocity of the segment is positive, or full scale negative if the final velocity of the segment is to be negative.
3) Acceleration: 1 to 2,147,483,647 indicates the acceleration or deceleration to be used in reaching the requested velocity or position.
4) Velocity: 0 to 2,147,483,647 indicating the desired ending velocity magnitude (speed) of the segment, or maximum velocity to use if coming to a stop within this segment. Will only be reached if it is consistent with the starting velocity, the acceleration, and the segment time.

See "Scaling" in the beginning of the manual for details on scaling the parameters to engineering units.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Interpolated Move Write Queue	Immediate (Class "A")	25 (0x19)	<< Time >>	0 to +2,147,483,647 (0 to 0x7FFFFFFF)
			<< Position >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)
			<< Acceleration >>	1 to 2,147,483,647 (0x01 to 0x7FFFFFFF)
			<< Velocity >>	0 to +2,147,483,647 (0 to 0x7FFFFFFF)

Example:

	TIME DATA	POSITION DATA	ACCEL DATA	VELOCITY DATA	
@16 25					**(CR)**

QuickContol Example:

Immediate (Host) Mode Command Only. See pages 11-12 for details

SilverMax Response:

ACK
NAK –FULL

Response Example:

*** 10 (CR)**

Negative Acknowledge (NAK) , Command 25 (0x19), Reason = Queue Full

! 10 0019 0006 (CR)

The NAK indicates that the data was rejected. This should commonly happen if the Host is keeping ahead of the SilverMax unit. It means that the queue has been kept full, and to send the data again. Periodic polling should also be done to see that the move has not improperly ended due to the Host falling behind the consumption rate of the SilverMax, and data not being available when needed.

MOVE ABSOLUTE, TIME BASED (MAT)

Description:

Move Absolute initiates a move to an Absolute position. Absolute positions are based on the Incremental Encoder resident in SilverMax. The move profile uses **Time** as the constraint for the Acceleration period and for the total move.

Absolute position is retained in SilverMax in a dedicated Data Register. If needed, the Absolute position can be reset to "0" using the **ZERO TARGET & POSITION** command, or offset to by the **CALC** command to make a latched location, such as an index, to be the "0" location without moving to it. Moves to an absolute position first calculate the Distance and Direction required to make a move. The move is then executed using the calculated Distance and Direction. This function eliminates the need to pre-calculate the move within the Host or inside of a user program.

The **Position Value Units** is in Encoder Counts. For a SilverMax with an encoder that provides 4000 counts per revolution, one revolution of the motor equals 4000 counts. To scale a move to revolutions, multiply the revolutions value by 4000.

Time based moves make the desired move within the times given. The Acceleration and Velocity are calculated to accommodate the time requirements. If the Acceleration or Velocity values needed to make the move exceed the maximum permissible limit, or the ramp times exceed 65534 ticks (120uS each) the move will not be executed and an error code will be set in the **Polling Status Word**. The **Polling Status Word** bit #14 **Foreground Command Error** will be set. Foreground command errors are generated when a command cannot be executed due to parameters that are out of range.

The **Total Time** is a time value in ticks. Ticks are based on update rate of the servo cycle, which is 120 microseconds long. The **Acceleration Time** is also represented by ticks. This time value defines the time needed to accelerate up to the calculated velocity. The **Total Time** and **Distance** must be consistent with the maximum velocity constraints of the motor (4000 RPM) to prevent the generation of an error. **Acceleration Time** can be no greater the ½ the **Total Time** value and not greater than 7.864 seconds in time (65534 ticks).

To convert **Total Time** and **Acceleration Time** to seconds multiply by 0.00012.

The **Stop Enable** and **Stop State** words determine which digital inputs and/or index signal are used to cause the motion to end before reaching the set Position. (See **Using Inputs to Stop a Motion** in the **SilverMax User Manual.)**

MOVE ABSOLUTE, TIME BASED (MAT)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Move Absolute, Time Based (Mat)	Program (Class "D")	176 (0xB0) [9 Words]	<< Position >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)
			<< Acceleration Time >>	0 to 65534 (0 to 0xFFFE)
			<< Total Time >>	2 to 2,147,483,647 (0x02 to 0x7FFFFFFF)
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax to position 200 in 1.0 seconds with a 0.1 second acceleration.

@16 176 200 83 8333 0 0(CR)

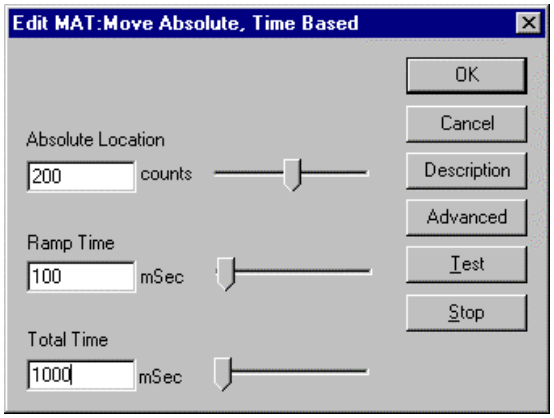
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



MOVE ABSOLUTE, VELOCITY BASED (MAV)

Description:

Move Absolute initiates a move to an Absolute position. Absolute positions are based on the Incremental Encoder resident in SilverMax. The move profile uses Acceleration and Velocity as the constraints.

Absolute position is retained in SilverMax in a dedicated Data Register. If needed the Absolute position can be reset to "0" using the **ZERO TARGET & POSITION** command. Moves to an absolute position first calculate the Distance and Direction required to make a move. The move is then executed using the calculated Distance and Direction. This function eliminates the need to pre-calculate the move from a Host or in a user program.

Velocity based moves use an Acceleration and Velocity parameter to accomplish the motion profile. If the Velocity value needed to make the move exceeds the maximum permissible limit, the move will not be executed and an error code will be set in the **Polling Status Word**. The **Polling Status Word** bit #14 **Foreground Command Error** will be set. Foreground command errors are generated when a command cannot be executed due to parameters that are out of range. If the Acceleration value exceeds the maximum permissible value, the Acceleration is limited to the maximum.

Acceleration parameter can be no greater than ½ the **Velocity** parameter.

The **Stop Enable** and **Stop State** words determine which digital inputs and/or index signal are used to cause the motion to end before reaching the set Position. (See **Using Inputs to Stop a Motion** in the **SilverMax User Manual.)**

MOVE ABSOLUTE, VELOCITY BASED (MAV)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Move Absolute, Velocity Based (MAV)	Program (Class "D")	134 (0x86) [9 Words]	<< Position >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)
			<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)
			<< Velocity >>	0 to 2,147,483,647 (0 to 0x7FFFFF)
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax to position 0 at 56000 cps.

@16 134 20000 10000 53687100 0 0(CR)

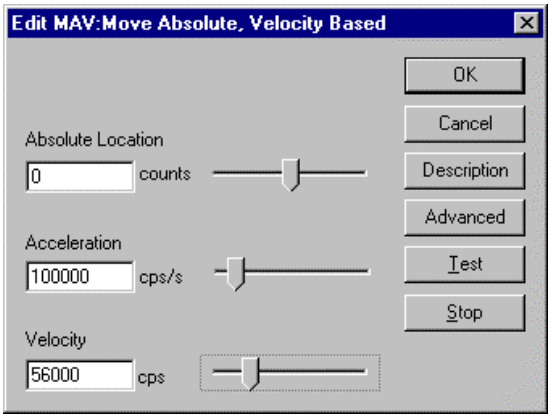
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



MOVE RELATIVE, TIME BASED (MRT)

Description:

Move Relative initiates a distance move relative to the current **Target Position**. **Relative Distances** are based on the **Incremental Encoder** resident in SilverMax. The move profile uses Time as the constraint for the **Acceleration** period and for the total move.

Relative Distance is an encoder count value that the motor will move from its current position. Providing a positive value will cause the motor move in a positive count direction. Giving a negative value will cause the motor to move in negative count direction. The polarity of the distance number always determines the direction that the motor will spin. This is not true for the **Absolute Position** commands, which will move the motor in the required direction to go to the requested Position.

The **Distance** units are in **Encoder Counts**. For a SilverMax with an encoder that provides 4000 counts per revolution, one revolution of the motor is 4000 counts. To scale a move to revolutions, multiply the revolutions value by 4000.

Time based moves will attempt to make the desired move within the times given. The Acceleration and Velocity are calculated to accommodate the time requirements. If the Acceleration or Velocity values needed to make the move exceed the maximum permissible limit the move will not be executed and an error code will be set in the **Polling Status Word**. The **Polling Status Word** bit #14 **Foreground Command Error** will be set. Foreground command errors are generated when a command cannot be executed due to parameters that are out of range.

The **Total Time** is a time value in ticks. Ticks are based on the time of a servo cycle which defines each tick as 120 microseconds long. The **Acceleration Time** is also represented by ticks. This time value defines the time needed to accelerate up to the calculated velocity. The **Total Time** and **Distance** must be consistent with the maximum velocity constraints of the motor (4000 RPM) to prevent the generation of an error. **Acceleration Time** can be no greater than ½ the **Total Time** value and not greater than 7.864 seconds in time (65534 ticks).

To convert **Total Time** and **Acceleration Time** to seconds multiply by 0.00012.

The **Stop Enable** and **Stop State** words determine which digital inputs and/or index signal are used to cause the motion to end before reaching the set Position. (See **Using Inputs to Stop a Motion** in the **SilverMax User Manual.)**

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Move Relative, Time Based (MRT)	Program (Class "D")	177 (0xB1) [9 Words]	<< Position >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)
			<< Acceleration Time >>	0 to 65534 (0 to 0xFFFE)
			<< Total Time >>	2 to 2,147,483,647 (0x02 to 0x7FFFFFFF)
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax 4000 counts from its current position. Do the move in 1 second with a 0.1 second acceleration.

@16 177 4000 833 8333 0 0(CR)

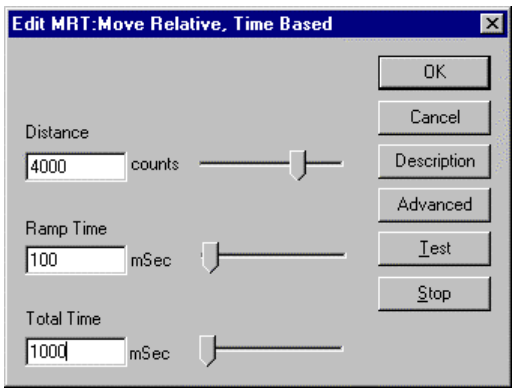
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



MOVE RELATIVE, VELOCITY BASED (MRV)

Description:

Move Relative initiates a distance move relative to the current **Target Position**. **Relative Distances** are based on the **Incremental Encoder** resident in SilverMax. The move profile uses Acceleration and Velocity as the constraints.

Relative Distance is an encoder count value that the motor will move from its current position. Providing a positive value will cause the motor to move in a positive count direction. Giving a negative value will cause the motor to move in negative count direction. The polarity of the distance number always determines the direction that the motor will spin. This is not true for the **Absolute Position** commands, which will move the motor in the required direction to go to the requested Position.

The Distance units are in **Encoder Counts**. For a SilverMax with an encoder that provides 4000 counts per revolution, one revolution of the motor is 4000 counts. To scale a move to revolutions, multiply the revolutions value by 4000.

Velocity based moves use an Acceleration and Velocity parameter to accomplish the motion profile. If the Velocity value needed to make the move exceeds the maximum permissible limit, the move will not be executed and an error code will be set in the **Polling Status Word**. The **Polling Status Word** bit #14 **Foreground Command Error** will be set. Foreground command errors are generated when a command cannot be executed due to parameters that are out of range. If the Acceleration value exceeds the maximum permissible value, the Acceleration is limited to the maximum.

See "**Scaling**" in the beginning of the manual for details on scaling the parameters to engineering units.

Acceleration parameter can be no greater than ½ the **Velocity** parameter.
† This pertains to raw SilverMax units only, not scaled parameters in QuickControl

The **Stop Enable** and **Stop State** words determine which digital inputs and/or index signal are used to cause the motion to end before reaching the set Position. (See **Using Inputs to Stop a Motion** in the **SilverMax User Manual.)**

MOVE RELATIVE, VELOCITY BASED (MRV)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Move Relative, Velocity Based (MAV)	Program (Class "D")	135 (0x87) [9 Words]	<< Distance >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)
			<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)
			<< Velocity >>	0 to 2,147,483,647 (0 to 0x7FFFFF)
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax -4000 counts from its current position.

@16 135 -4000 10000 53687100 0 0(CR)

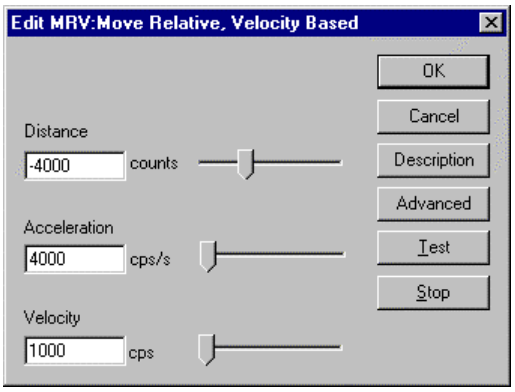
SilverMax Response:

ACK only

Response Example:

***10 (CR)**

QuickControl Example:



PRE-CALCULATED GO (PCG)

See Also: **PRE-CALCULATE MOVE (PCM)**

Description:

After a **Pre-Calculate Move** command has been successfully executed, the pre-calculated move is in a ready state. The **GO** command initiates the move, which will begin immediately (within 120 usec.)

If the pre-calculation was bad (parameters out of range) or a second Motion command precedes the **GO**, a **Program Error** will result and the motor will be shut down.

It is not required for the **GO** command to immediately follow the Motion command. Other commands that do not affect the Motion intermediate values can be executed before the **GO**. A second Motion command or the Velocity Mode command before the **GO** will cause a **Program Error**.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Pre-Calculated Go (PCG)	Program (Class "D")	231 (0xE7) [1 Word]	NONE	NONE

Example:

Perform the Calculation Task on following Motion command.

@16 231 (CR)

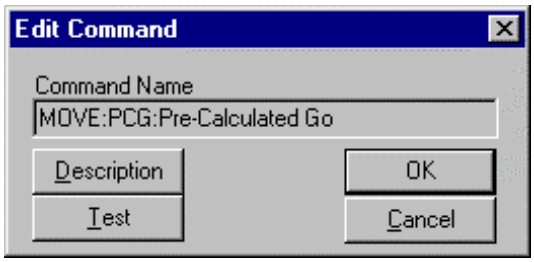
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PRE-CALCULATE MOVE (PCM)

See Also: **PRE-CALCULATED GO (PCG)**

Description:

The **Pre-Calculate Move** command causes SilverMax to perform just the **Calculation** task on a **Motion** command. The **Motion** command to be precalculated must immediately follow the **Pre-Calculate Move** command or no action is taken. When this command has been successfully executed, the pre-calculated move will be in a ready state waiting for the **Pre-Calculated Go** command.

Command Info:

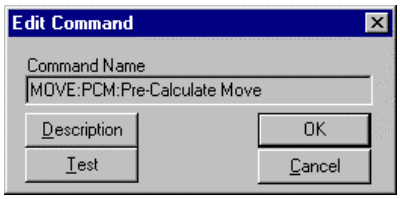
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Pre-Calculated Move (PCM)	Program (Class "D")	232 (0xE8) [1 Word]	NONE	NONE

Example:

Start the pre-calculated move.

@16 232 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

PROFILE MOVE CONTINUOUS (PMC)

Description:

The **Profile Move** commands are distinct from the Motion commands in that the move parameters can be modified while the motion is in progress. A change in a move parameter updates the move immediately and can alter the move profile "real-time".

The **Profile Move Continuous** puts SilverMax into a move that does not end unless explicitly commanded. During the move, any move parameter can be updated either by a Host controller using the serial interface or by an internal program (**Multi-Tasking** operation is required).

With this feature, any motion profile shape can be accomplished by changing the appropriate parameter at the desired time. Five parameters are associated with this command. Each of the parameters is dedicated to a specified **User Data Register**. Modifying the contents of the **Data Register** modifies the parameter.

See "**Scaling**" in the beginning of the manual for details on scaling the parameters to engineering units.

The following table shows the list of the parameters and their associated Data Register:

Data Register	Description	Data Range	Comment
20	**Position**	-2,147,483,648 to +2,147,483,647	This is an "Absolute" destination value.
21	**Acceleration**	2 to 1,073,741,823	Sets the acceleration rate that is used when increasing the move speed.
22	**Velocity**	0 to 2,147,483,647	The maximum speed that is allowed during a move
23	**Deceleration**	2 to 1,073,741,823	Sets the deceleration rate that is used when decreasing the move speed.
24	**Offset**	-2,147,483,648 to +2,147,483,647	A distance value to move that is added to the current position when a "Stop Condition" is encountered

Data Registers must be pre-loaded with the move parameters prior to issuing the **Profile Move Continuous** command.

Profiles Moves begin immediately after executing the command (within 120 usec.). The motor is accelerated using the **Acceleration** parameter until the maximum **Velocity** is reached. **Deceleration** begins when the distance of the move is such that the **Absolute Position** is achieved at the same time the motor has decelerated to "0" velocity. Depending on the parameters the maximum velocity may never be reached (Triangle Move).

During a **Profile Move**, SilverMax is constantly recalculating its intermediate move values (every 120 usec.). This is done by taking the given move parameters, the **Current Position** and **Current Velocity** and adjusting what is required to hit the **Absolute Position**. This means that SilverMax can even go from a **Velocity Mode** into a **Profile Move** without needing to stop first (Multi-Tasking operation is required). Remember that the move calculations are being done continually. Therefore, the parameters can be changed at any time and affect the motion in process.

The **Acceleration** and **Deceleration** parameters should typically be no greater than a ratio of 100:1 of each other (one value is no greater than 100 times the other) for numerical stability. For higher ratios user must verify proper operation.

The **Position** parameter can act as a **Relative Distance** value by using the **ADD TO REGISTER** command to increase or decrease the Position value. (See **ADD TO REGISTER** for more details)

The **Offset** parameter is used to extend a move by the **Offset Distance** after a **Stop Condition** is encountered. In cases where a move needs to continue a prescribed distance past the point where a sensor triggers a stop, this parameter can be used to precisely control that offset distance to be moved.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Profile Move Continuous (PMC)	Program (Class "D")	240 (0xF0) [3 Words]	<Stop Enable>	0 to 65535 {–1 to –14} (0 to 0xFFFF)
			<Stop State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)

Example:

Put SilverMax into a continuous Profile move. Stop if Input #1 is high ("1").

@16 240 –1 1 (CR)

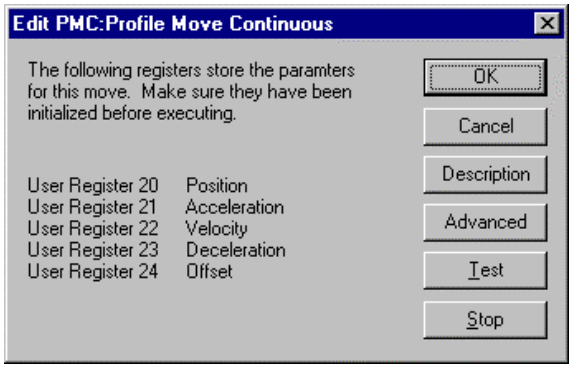
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PROFILE MOVE OVERRIDE (PMO)

See Also: **PROFILE MOVE CONTINUOUS (PMC)**

Description:

The **Profile Move Override** command allows a **Profile Move Continuous** to end when the Position is achieved. Normally the **Move Continuous** will not end until explicitly stopped by a **Stop Condition** or another command. The O**verride** provides a graceful way to end the move so that the entire motion is completed with the motor stopping at the defined position. PMO will also override all other motions, including Step and Direction, if multitasking is enabled.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Profile Move Override (PMO)	Program (Class "D")	249 (0xF9) [3 Words]	<Stop Enable>	0 to 65535 {–1 to –14} (0 to 0xFFFF)
			<Stop State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)

Example:

End the current Profile move when at "Position". Stop if Input #1 is high ("1").

@16 249 –1 1 (CR)

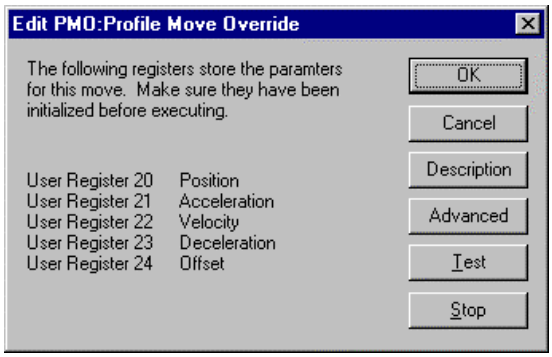
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PROFILE MOVE (PMV)

See Also: **PROFILE MOVE CONTINUOUS (PMC)**

Description:

The **Profile Move** command works identical to the **Profile Move Continuous** except that when the Position is achieved, the move ends (stops and goes into position holding mode). All of the parameters including the position can be changed while the move is executing. Once the move has ended, changing the parameters will have no effect.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Profile Move (PMV)	Program (Class "D")	241 (0xF1) [3 Words]	<Stop Enable>	0 to 65535 {–1 to –14} (0 to 0xFFFF)
			<Stop State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)

Example:

Start a SilverMax Profile move. Stop if Input #1 is high ("1").

@16 241 –1 1 (CR)

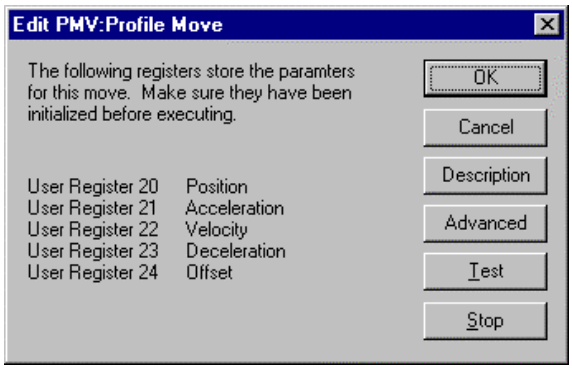
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PROFILE MOVE EXIT (PMX)

See Also: **PROFILE MOVE CONTINUOUS (PMC)**

Description:

Exits the current Profile Move allowing the move to stop using the **Deceleration** parameter stored in **Data Register #23**. This command will work to stop any **Motion**, **Profile Move** or **Mode**. The deceleration begins immediately and the profile destination will not be reached.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Profile Move Exit (PMX)	Program (Class "D")	242 (0xF2) [1 Word]	NONE	NONE

Example:

Exit the current move.

@16 242 (CR)

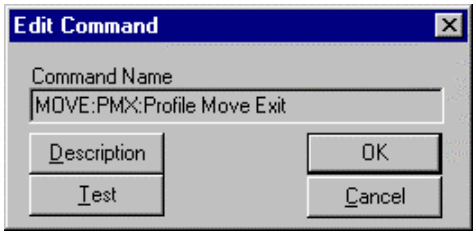
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



REGISTER MOVE ABSOLUTE, TIME BASED (RAT)

Description:

The **Register Move Absolute** performs an absolute move using a position value contained in the indicated **User Data Register**. This command works like the basic **Move Absolute, Time Based (MAT)** command in all other ways.

The Register Move Absolute is useful when the position value needs to be calculated internally or if the command is being executed in a program and the position value needs to be dynamically updated through the Serial Interface.

See "**Scaling**" in the beginning of the manual for details on scaling the parameters to engineering units.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Register Move Absolute, Time Based (RAT)	Program (Class "D")	178 (0xB2) [9 Words]	<<Data Register >>	10 to 40
			<< Acceleration Time >>	0 to 65534 (0 to 0xFFFE)
			<< Total Time >>	2 to 2,147,483,647 (0x02 to 0x7FFFFFFF)
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax to position indicated by User Data Register #11 in 9500.01 mSec with a 235.92 mSec acceleration.

@16 178 11 1965 79166 0 0(CR)

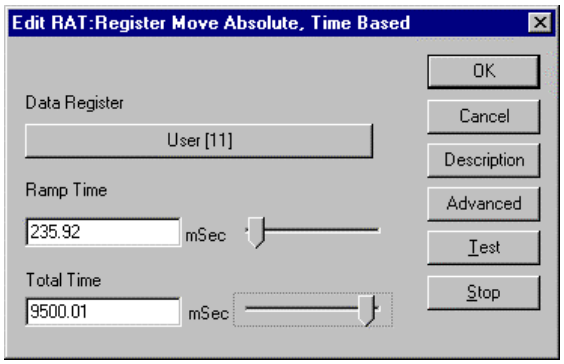
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



REGISTER MOVE ABSOLUTE, VELOCITY BASED (RAV)

Description:

The **Register Move Absolute** performs an absolute move using a position value contained in the indicated **User Data Register**. This command works like the basic **Move Absolute, Velocity Based (MAV)** command in all other ways.

The Register Move Absolute is useful when the position value needs to be calculated internally or if the command is being executed in a program and the position value needs to be dynamically updated through the Serial Interface.

See "**Scaling**" in the beginning of the manual for details on scaling the parameters to engineering units.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Register Move Absolute, Velocity Based (RAV)	Program (Class "D")	160 (0xA0) [9 Words]	<<Data Register >>	0 to 40
			<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)
			<< Velocity >>	0 to 2,147,483,647 (0 to 0x7FFFFF)
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax to position indicated by User Data Register #11.

@16 160 11 10000 53687100 0 0(CR)

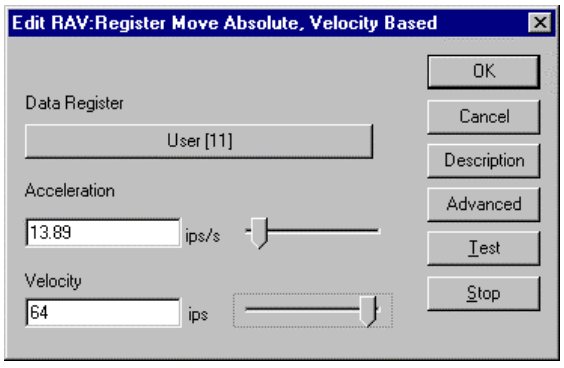
SilverMax Response:

ACK only

Response Example:

***10 (CR)**

QuickControl Example:



REGISTER MOVE RELATIVE, TIME BASED (RRT)

Description:

The **Register Move Relative** performs a relative move using a distance value contained in the indicated **User Data Register**. This command works like the basic **Move Relative, Time Based (MRT)** command in all other ways.

The Register Move Relative is useful when the position value needs to be calculated internally or if the command is being executed in a program and the position value needs to be dynamically updated through the Serial Interface.

See "**Scaling**" in the beginning of the manual for details on scaling the parameters to engineering units.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Register Move Relative, Time Based (RRT)	Program (Class "D")	179 (0xB3) [9 Words]	<<Data Register >>	0 to 40
			<< Acceleration Time >>	0 to 65534 (0 to 0xFFFE)
			<< Total Time >>	2 to 2,147,483,647 (0x02 to 0x7FFFFFFF)
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax to position indicated by User Data Register #11. Do the move in 8 seconds with a 0.400 second acceleration.

@16 179 11 3333 66664 0 0(CR)

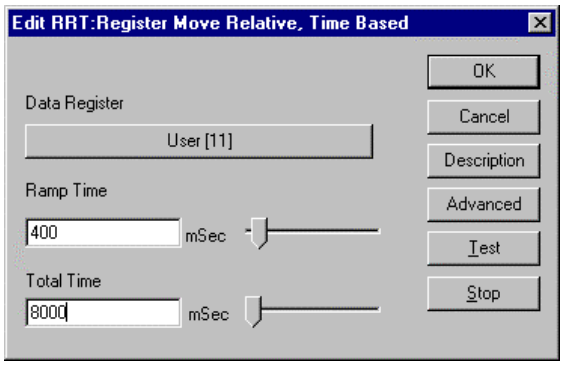
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



REGISTER MOVE RELATIVE, VELOCITY BASED (RRV)

Description:

The **Register Move Relative** performs a relative move using a distance value contained in the indicated **User Data Register**. This command works like the basic **Move Relative, Velocity Based (MRV)** command in all other ways.

The Register Move Relative is useful when the position value needs to be calculated internally or if the command is being executed in a Program and the Position value needs to be dynamically updated through the Serial Interface.

See "**Scaling**" in the beginning of the manual for details on scaling the parameters to engineering units.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Register Move Relative, Velocity Based (RRV)	Program (Class "D")	161 (0xA1) [9 Words]	<<Data Register >>	0 to 40
			<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)
			<< Velocity >>	0 to 2,147,483,647 (0 to 0x7FFFFFF)
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax to position indicated by User Data Register #26.

@16 161 26 10000 53687100 0 0(CR)

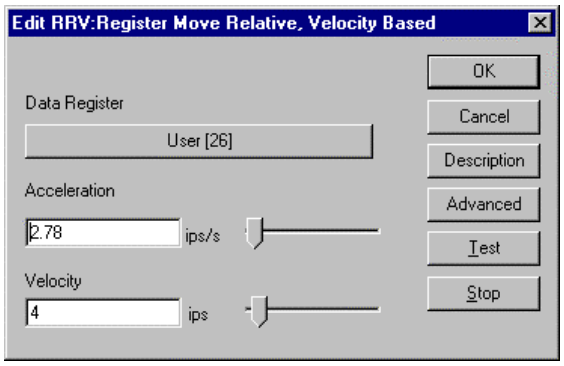
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



EXTENDED REGISTER MOVE ABSOLUTE, TIME BASED (XAT)

See Also: **Write Register & CALCULATION commands**

Description:

The **Extended Register Move Absolute** performs an absolute position move using move parameters contained in the indicated **User Data Registers**. This command works like the basic **Move Absolute, Time Based (MAT)** command in all other ways.

The move parameters are retrieved from the **User Data Registers** in the following order:
If **Starting Data Register** = N:

N = **Position**
N + 1 = **Acceleration Time**
N + 2 = **Total Time**

The move parameters must be written into the **User Data Registers** prior to executing the move command. The range of the move parameters stored in the **User Data Registers** must be the same as those used in the basic **Move Absolute, Time Based (MAT)** command. The **Write Register** commands can be used to write the move parameters into the Data Registers. The **Write Register** commands do not type check the parameters when written, therefore errors may occur at time of execution. Changing the move parameters during an actual move will have no affect on the move in progress.

The Extended Register Move Absolute is useful when the move parameters need to be calculated internally or if the command is being executed in a program and the move parameters need to be dynamically updated through the Serial Interface.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Extended Register Move Absolute, Time Based (XAT)	Program (Class "D")	236 (0xEC) [4 Words]	<<Starting Data Register >>	10 to 40
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax using parameters from User Data Registers #20-22.

@16 236 20 0 0(CR)

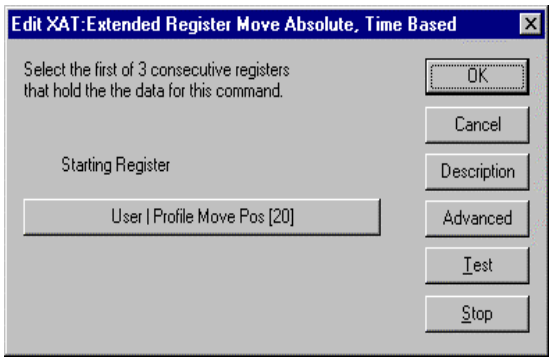
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



EXTENDED REGISTER MOVE ABSOLUTE, VELOCITY BASED (XAV)

See Also: **Write Register & CALCULATION commands**

Description:

The **Extended Register Move Absolute** performs an absolute position move using move parameters contained in the indicated **User Data Registers**. This command works like the basic **Move Absolute, Velocity Based (MAV)** command in all other ways.

The move parameters are retrieved from the **User Data Registers** in the following order:
If **Starting Data Register** = N:

N = **Position**
N + 1 = **Acceleration**
N + 2 = **Velocity**

The move parameters must be written into the **User Data Registers** prior to executing the move command. The range of the move parameters stored in the **User Data Registers** must be the same as those used in the basic **Move Absolute, Velocity Based (MAV)** command. The **Write Register** commands can be used to write the move parameters into the Data Registers. The **Write Register** commands do not type check the parameters when written, therefore errors may occur at time of execution. Changing the move parameters during an actual move will have no affect on the move in progress.

See "**Scaling**" in the beginning of the manual for details on scaling the parameters to engineering units.

The Extended Register Move Absolute is useful when the move parameters need to be calculated internally or if the command is being executed in a program and the move parameters need to be dynamically updated through the Serial Interface.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Extended Register Move Absolute, Velocity Based (XAV)	Program (Class "D")	234 (0xEA) [4 Words]	<<Starting Data Register >>	10 to 40
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax using parameters from User Data Registers #25-27.

@16 234 25 0 0 (CR)

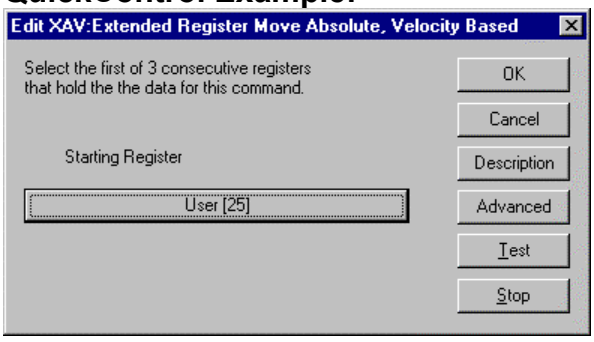
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



EXTENDED REGISTER MOVE RELATIVE, TIME BASED (XRT)

See Also: **Write Register & CALCULATION commands**

Description:

The **Extended Register Move Relative** performs a relative distance move using move parameters contained in the indicated **User Data Registers**. This command works like the basic **Move Relative, Time Based (MRT)** command in all other ways.

The move parameters are retrieved from the **User Data Registers** in the following order:
If **Starting Data Register** = N:

N = **Distance**
N + 1 = **Acceleration Time**
N + 2 = **Total Time**

The move parameters must be written into the **User Data Registers** prior to executing the move command. The range of the move parameters stored in the **User Data Registers** must be the same as those used in the basic **Move Relative, Time Based (MRT)** command. The **Write Register** commands can be used to write the move parameters into the Data Registers. The **Write Register** commands do not type check the parameters when written, therefore errors may occur at time of execution. Changing the move parameters during an actual move will have no affect on the move in progress.

The Extended Register Move Relative is useful when the move parameters need to be calculated internally or if the command is being executed in a program and the move parameters need to be dynamically updated through the Serial Interface.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Extended Register Move Relative, Time Based (XRT)	Program (Class "D")	178 (0xB2) [9 Words]	<<Starting Data Register >>	10 to 40
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax using parameters from User Data Registers #30-32.

@16 234 30 0 0 (CR)

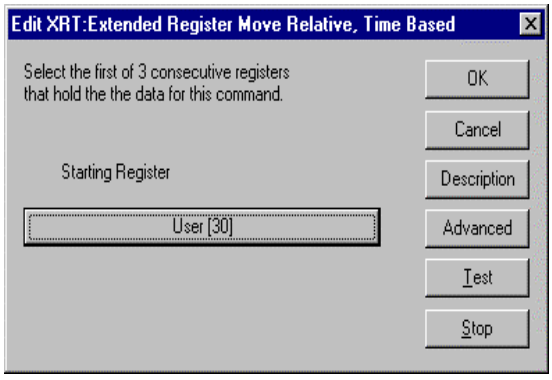
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



EXTENDED REGISTER MOVE RELATIVE, VELOCITY BASED (XRV)

See Also: **Write Register & CALCULATION commands**

Description:

The **Extended Register Move Relative** performs a relative distance move using move parameters contained in the indicated **User Data Registers**. This command works like the **Move Relative, Velocity Based (MRV)** command in all other ways.

The move parameters are retrieved from the **User Data Registers** in the following order:
If **Starting Data Register** = N:

N = **Distance**
N + 1 = **Acceleration**
N + 2 = **Velocity**

The move parameters must be written into the **User Data Registers** prior to executing the move command. The range of the move parameters stored in the **User Data Registers** must be the same as those used in the basic **Move Relative, Velocity Based (MRV)** command. The **Write Register** commands can be used to write the move parameters into the Data Registers. The **Write Register** commands do not type check the parameters when written, therefore errors may occur at time of execution. Changing the move parameters during an actual move will have no affect on the move in progress.

See "**Scaling**" in the beginning of the manual for details on scaling the parameters to engineering units.

The Extended Register Move Relative is useful when the move parameters need to be calculated internally or if the command is being executed in a program and the move parameters need to be dynamically updated through the Serial Interface.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Extended Register Move Relative, Velocity Based (XRV)	Program (Class "D")	178 (0xB2) [9 Words]	<<Starting Data Register >>	10 to 40
			< Stop Enable >	0 to 65535 (0 to 0xFFFF)
			< Stop State >	0 to 65535 (0 to 0xFFFF)

Example:

Move SilverMax using parameters from User Data Registers #20-22.

@16 234 20 0 0 (CR)

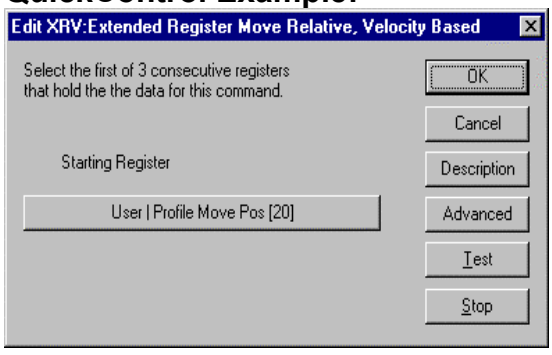
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Program Flow Commands

CALCULATION (CLC)

See Also: **Data Register Commands**

Description:

The **Calculation** command provides basic math, logic and other function using **Data Registers**. The command uses two parameters, **Operation** and **Data Register,** to perform all of its defined operations. Several of the operations have two Operands to perform the calculation. When two Operands are required, **Data Register #10** is used as one of the operands while the selected **Data Register** is used for the second operand. Typically, **Data Register #10** is used as the destination for a two-operand operation. For single Operand operations, the selected **Data Register** is used as the source and/or destination.

Data Register #10 is typically used as an **accumulator** but may also be the Selected **Data Register**.

All **Data Registers** are 32 bit in size. Depending on their usage, they take on a signed or unsigned character. When used for **Position** or **Distance** data they are used in a signed fashion. When used as a Counter they may be unsigned.

The Multiply and Divide math operations use only the lower 16 bits of the **Data Registers**, therefore only 16-bit math can be done on the operands. This limit is due to the 32 bit **Data Register** being the only location for storage of the result. (16 bit X 16 bit = 32 bit number)

When performing math functions the Read Only **Data Registers #0 to #9** can be used as the selected **Data Register**. Data cannot be Saved or Written to these Registers due to their Read Only nature. **User Data Registers #10 to #40** can be used for any purpose as they are designed for both Read and Write operations. (See **Data Register Commands** for more information.)

Calculations affect the conditions of the **Internal Status Word.** Depending on the result of an operation one of three different conditions will occur. (See **Internal Status Word** in **the SilverMax User Manual** for more details.)

NOTE: This command has 2 command numbers. 215 uses separate words for Operation and Data Register. 165 uses 1 single word for both. Upper Byte holds Operation and lower Byte holds Data Register.

Calculation Code Table

CODE	OPERATION	DESCRIPTION
0	**Clear**	Clears out the indicated register
1	**Add**	Adds the selected register to register 10 with the result remaining in register 10
2	**Subtract**	Subtracts the selected register from register 10 with the result remaining in register 10
3	**Copy**	Copies the selected register to register 10
4	**Increment**	Increments the selected register
5	**Decrement**	Decrements the selected register
6	**Absolute Value**	Takes the absolute value of the selected register, saves it back into selected register
7	**Subtract Target Position**	Subtracts the selected register from both the Target and Position registers. This allows for doing modulo calculations
8	**Save**	Copies Register #10 to the selected Register.
9	**Load High Word**	Loads the high word of the selected register (upper 16 bits), with sign extend, into register #10.
10	**Load Low Word**	Loads the low word of the selected register (lower 16 bits), with sign extend, into register #10.
11	**AND**	Bitwise AND the selected register with register #10 with the result in placed in register #10
12	**OR**	Bitwise OR the selected register with register #10 with the result in placed in register #10
13	**XOR**	Bitwise Exclusive OR the selected register with register #10 with the result placed in register #10
14	**DIV**	Divide absolute value low word of Register #10 by the absolute value of low word of selected Data Register. Result is placed Register #10
15	**UMULT**	Unsigned multiply of register #10 low word and low word of selected register. Result is placed in Register #10.
16	**MULT**	Signed multiply of Register #10 low word of and low word of selected register. Result is placed in Register #10
17	**PACK**	Replace the upper word of Register #10 with the low word of the selected register
18	**LOAD INDIRECT**	Loads Register #10 with the contents of the Register addressed by the data within the Selected Register (selected register is a pointer to the data location).
19	**SAVE INDIRECT**	Saves Register #10 contents to the Register addressed by the data within the Selected Register (selected register is a pointer to the data save location).
20	**SAVE HIGH**	Saves the Low word of Register #10 to the High word of the selected register. Used to write to half of a combined word register.
21	**SAVE LOW**	Saves the Low word of Register #10 to the Low word of the selected register. Used to write to half of a combined word register
22	**SHIFT LEFT**	Performs a 32 bit Left Shift of the selected Register.
23	**SHIFT RIGHT SIGN EXTENDED**	Performs a 32 bit sign extended right shift of the selected Register. Implements a signed divide by 2.
24	**SHIFT RIGHT**	Performs a 32 bit right shift of the selected Register. Implements an unsigned divide by 2.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Calculation (CLC)	Program (Class "D")	215 (0xD7) [3 Words]	< Operation >	See Previous Table
		165 2 words < operation/ Data Reg. > Upper Byte = Operation Lower Byte = Data Reg.		
			< Data Register >	0 to 40 200 to 211

Example:

Decrement Accumulator

@16 215 5 10 (CR)

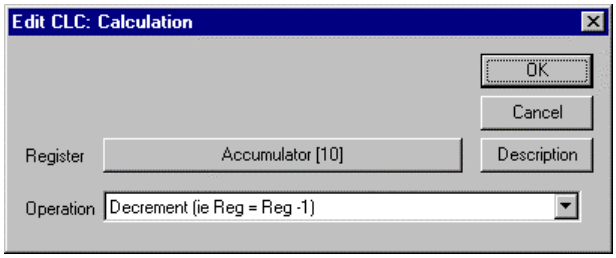
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Clear Program (CLP)

Description:

The **Clear Program** prepares the SilverMax unit for downloading into the **Program Buffer**. First, the **Program Buffer** is cleared. Then the buffer pointer is set to the beginning of the buffer. This command is used prior to a **Start Download** command. It sets up the buffer to properly receive a program.

This command may also be used to end the program download initiated by a **Start Download** command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Clear Program (CLP)	Immediate (Class "B")	8 (0x8)	NONE	NONE

Example:

Clear the SilverMax Program Buffer.

@16 8 (CR)

QuickControl Example:

Immediate (Host) Mode Command Only

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

DELAY (DLY)

Description:

The **Delay** command sets a **Delay Counter** (Register 5) with the supplied parameter. The counter is decremented every servo cycle (120 microseconds). If the **Tick Count** is positive, the given value is used for the counter and a **WAIT DELAY** command is automatically executed. If the value is negative, the absolute value of the parameter is loaded into the counter and the execution continues on to the next command in the Program Buffer. The **Delay Counter** (Register 5) is Read/Write for code version REV321 and higher.

The **Delay Counter**, if not being used for program delays, may be used in a "watch dog" configuration. The counter would be kept refreshed by writing to Register 5 through the serial interface. The **Delay Counter Bit** in the **Kill Motor Mask** would be enabled. As long as the counter is not allowed to reach zero, the **Delay Counter Bit** in the **Internal Status Word** stays low. If the host were to shutdown or lose communications, the counter would reach zero, causing a **Kill Motor** operation, running a recovery routine if one were enabled.

A Tick Count equals 120 microseconds in time. To convert to seconds multiply the Tick Count by 0.00012. A one second delay (rounded off) is 8333 Tick Counts .

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Delay (DLY)	Program (Class "D")	140 (0x8C) [3 Words]	<< Tick Count >>	-2,147,483,647 to 2,147,483,647 (0x8000001 to 0x7FFFFFFF)

Example:

Cause SilverMax to delay program execution by 1.2 seconds.

@16 140 10000 (CR)

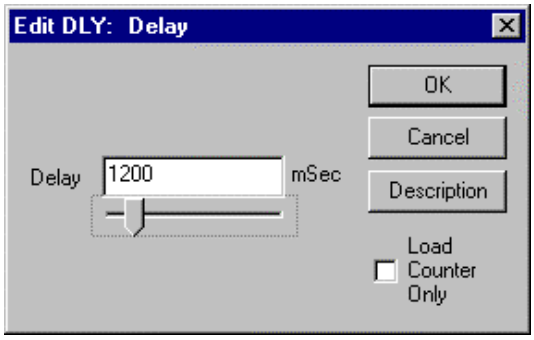
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



END PROGRAM (END)

Description:

SilverMax programs typically end when the last line of the program is completed. If the program needs to end based on a **Conditional Jump,** the **End Program** command can be inserted in the program at the desired point. When this command is executed, the currently running program will stop executing and the motor will be placed in a Host Mode. Programs can also be stopped by issuing any of the **Override Commands**.

This command does nothing if sent to the motor when it is in **Host Mode**.

Command Info:

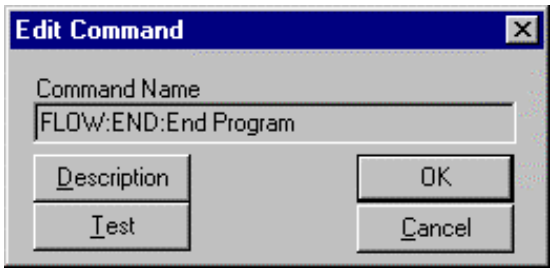
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
End Program (END)	Program (Class "D")	128 (0x80) [1 Word]	NONE	NONE

Example:

As part of a program, end program execution.

@16 128 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

JUMP ON INPUTS, AND-ed (JAN)

Description:

The **Jump On Inputs, AND-ed** command allows looping and other conditional branching inside a program based on the condition of the **I/O State Word (IOS).** The **IOS Condition Enable** selects which inputs will be used in the AND-ed evaluation. The **IOS Condition State** allows the user to specify the states (High "1" or Low "0") of the selected inputs that will cause a **TRUE** condition for each of the inputs. Setting both parameters to "zero" forces an unconditional jump to the specified Program Buffer location.

The condition **TRUE** evaluation is done by **AND-ing** the enabled inputs together. If all the enabled inputs are **TRUE** a jump will occur.

Table Showing the Bit definitions for the I/O State Word (IOS)

Bit #	IOS bit # 15-8 definitions	Bit #	IOS bit # 7-0 definitions
Bit 15	I/O #7	Bit 7	Over Temperature ("0" = True)
Bit 14	I/O #6	Bit 6	I/O #3
Bit 13	I/O #5	Bit 5	I/O #2
Bit 12	I/O #4	Bit 4	I/O #1
Bit 11	reserved	Bit 3	Trajectory Generator Active
Bit 10	Delay Counter Active	Bit 2	External Index
Bit 9	Holding Error	Bit 1	Internal Index
Bit 8	Moving Error	Bit 0	INDEX (Multiplexed)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range(Hex)
Jump On Inputs, And-Ed (JAN)	Program (Class "E")	250 (0xEE) [4 Words]	< IOS Condition Enable >	0 to 65535
			< IOS Condition State >	0 to 65535
			<Program Buffer Location>	0 to 199

Example:

Jump to Program Buffer location 10 if digital inputs #4, #5, #6 and #7 are High ("1").

@16 250 61440 61440 10 (CR)

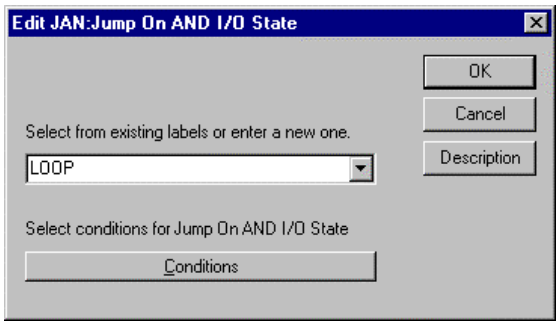
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

Quick Control Example:



JUMP ON INPUTS, NAND-ed (JNA)

Description:

The **Jump On Inputs, NAND-ed** command allows looping and other conditional branching inside a program based on the condition of the **I/O State Word (IOS).** The **IOS Condition Enable** selects which inputs will be used in the NAND-ed (Negative AND-ed) evaluation. The **IOS Condition State** allows the user to specify the states (High "1" or Low "0") of the selected inputs that will cause a **TRUE** condition for each of the inputs. Setting both parameters to "zero" forces an unconditional jump to the specified Program Buffer location.

The condition **TRUE** evaluation is done by N**AND-ing** the enabled inputs together. If all the enabled inputs are **TRUE** a jump will **NOT** occur. This means that a jump will always occur when any of the conditions are **FALSE**.

Table Showing the Bit definitions for the I/O State Word (IOS)

Bit #	IOS bit # 15-8 definitions	Bit #	IOS bit # 7-0 definitions
Bit 15	I/O #7	Bit 7	Over Temperature ("0" = True)
Bit 14	I/O #6	Bit 6	I/O #3
Bit 13	I/O #5	Bit 5	I/O #2
Bit 12	I/O #4	Bit 4	I/O #1
Bit 11	reserved	Bit 3	Trajectory Generator Active
Bit 10	Delay Counter Active	Bit 2	External Index
Bit 9	Holding Error	Bit 1	Internal Index
Bit 8	Moving Error	Bit 0	INDEX (Multiplexed)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range(Hex)
Jump On Inputs, And-Ed (JNA)	Program (Class "E")	238 (0xEE) [4 Words]	< IOS Condition Enable >	0 to 65535
			< IOS Condition State >	0 to 65535
			<Program Buffer Location>	0 to 199

Example:

Don't jump to Program Buffer location 10 if digital inputs #4, #5, #6 and #7 are High ("1").

@16 238 61440 61440 10 (CR)

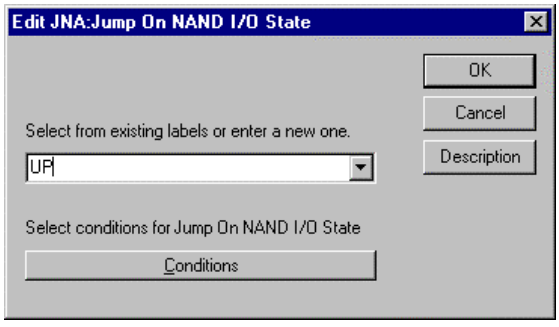
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



JUMP ON INPUTS, OR-ed (JOR)

Description:

The **Jump On Inputs, OR-ed** command allows looping and other conditional branching inside a program based on the condition of the **I/O State Word (IOS).** The **IOS Condition Enable** selects which inputs will be used in the OR-ed evaluation. The **IOS Condition State** allows the user to specify the states (High "1" or Low "0") of the selected inputs that will cause a **TRUE** condition for each of the inputs. Setting both parameters to "zero" forces an unconditional jump to the specified Program Buffer location.

The condition **TRUE** evaluation is done by **OR-ing** the enabled inputs together. If any of the enabled inputs are **TRUE** a jump will occur.

Table Showing the Bit definitions for the I/O State Word (IOS)

Bit #	IOS bit # 15-8 definitions	Bit #	IOS bit # 7-0 definitions
Bit 15	I/O #7	Bit 7	Over Temperature ("0" = True)
Bit 14	I/O #6	Bit 6	I/O #3
Bit 13	I/O #5	Bit 5	I/O #2
Bit 12	I/O #4	Bit 4	I/O #1
Bit 11	reserved	Bit 3	Trajectory Generator Active
Bit 10	Delay Counter Active	Bit 2	External Index
Bit 9	Holding Error	Bit 1	Internal Index
Bit 8	Moving Error	Bit 0	INDEX (Multiplexed)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range(Hex)
Jump On Inputs, Or-Ed (JOR)	Program (Class "E")	239 (0xEF) [4 Words]	< IOS Condition Enable >	0 to 65535
			< IOS Condition State >	0 to 65535
			<Program Buffer Location>	0 to 199

Example:

Jump to Program Buffer location 0 if input #1 or #2 or #3 is High ("1").

@16 162 112 112 0 (CR)

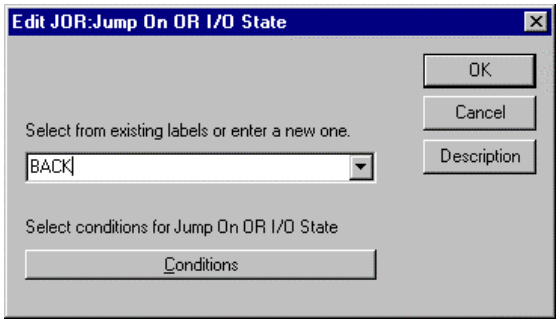
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



JUMP (JMP)

Description:

The **Jump** command allows looping and other conditional branching inside a program based on the condition of the **Internal Status Word**. The **Condition Enable** word selects which bits in the **Internal Status Word** will be evaluated. A "1" in the bit position enables looking at that bit. The **Condition State** word allows the user to specify the state (High "1" or Low "0") of the selected bits that will cause the jump to occur. Setting the **Condition Enable** word to "zero" forces an unconditional jump to the specified Program Buffer location. A match on any of the selected bits caused the jump to occur.

The conditions available in the **Internal Status Word** are as follows:

Internal Status Word

Bit 0 = Index Found
Bit 1 = Last Calculation was zero
Bit 2 = Last Calculation was Positive
Bit 3 = Last Calculation was Negative
Bit 4 = Input #1
Bit 5 = Input #2
Bit 6 = Input #3
Bit 7 = Over temperature (if bit is low)
Bit 8 = Motion Error (From Error Limit
Bit 9 = Position Error (From Error Limit)
Bit 10 = Halt command was sent
Bit 11 = Sensor found on last move
Bit 12 = Wait Delay count exhausted
Bit 13 = Over Voltage
Bit 14 = Under Voltage
Bit 15 = Reserved

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Jump (JMP)	Program (Class "E")	162 (0xA2) [4 Words]	<Condition Enable>	0 to 32767 (0 to 0x7FFF)
			<Condition State>	0 to 32767 (0 to 0x7FFF)
			< Program Buffer Location >	0 to 199 (0 to 0xC7)

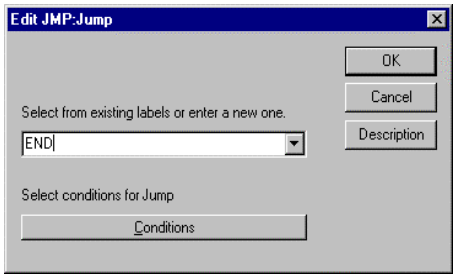
Example:

JUMP to Program Buffer Location 0 if the last calculation using the Calculation command was zero

Jump to Program Buffer location 0 last calculation was zero.

@16 162 2 2 0 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

Table Showing the Bit definitions for the Internal Status Word (ISW)

	Bit #	**ISW** bit # 15-8 definitions		Bit #	**ISW** bit # 7-0 definitions
	Bit 15	reserved		Bit 7	Over temperature (“0” = True)
	Bit 14	Under voltage		Bit 6	I/O #3
	Bit 13	Over voltage		Bit 5	I/O #2
	Bit 12	Wait Delay exhausted		Bit 4	I/O #1
	Bit 11	Input found on last move		Bit 3	Negative **Calculation** result
	Bit 10	Halt command was sent		Bit 2	Positive **Calculation** result
	Bit 9	Holding error	X	Bit 1	Zero **Calculation** result
	Bit 8	Moving error		Bit 0	Index sensor found

Table Showing Data going from a Binary word to a Hexadecimal word

Place a “1” in bit that is to be used

Bit # (for reference)	*15*	*14*	*13*	**12**	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Bit Values (For reference)	*8*	*4*	*2*	**1**	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*	*8*	*4*	*2*	*1*
Binary Word	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	1	0
Nibbles	**0**				**0**				**0**				**2**			
Hexadecimal Word	**0002**															

Hexadecimal 0x0002 = 2 in decimal

The Condition Enable and the Condition States just happen to have the same bits set, therefore the number “2” will work for both.

JUMP ON INPUT (JOI)

Description:

The **Jump On Input** command allows looping and other conditional branching inside a program based on the condition of an **External Digital Input** or an **Internal Input**. This command is actually the same number as the **Jump** command, however, by using a negative number for the first parameter the usage of the command changes. The **Jump Enable Code** selects which input will be evaluated. The **Input State** allows the user to specify the state (High "1" or Low "0") of the selected input that will cause the jump to occur. Setting both parameters to "zero" forces an unconditional jump to the specified Program Buffer location.

JUMP Enable Code	Input Source	Description
0		Do an unconditional Jump
-1	External	I/O #1
-2	"	I/O #2
-3	"	I/O #3
-4	"	I/O #4
-5	"	I/O #5
-6	"	I/O #6
-7	"	I/O #7
-8	"	Current Index Sensor
-9	"	Internal Index Sensor
-10	"	External Index Sensor
-11	Internal	Moving Error Status
-12	"	Holding Error Status
-13	"	Trajectory Generator Active
-14	"	Delay Counter Active

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Jump On Input (JOI)	Program (Class "E")	162 (0xA2) [4 Words]	JUMP Enable Code	-1 to -14
			Input State	0 = "Low" 1 = "High"
			<Program Buffer Location>	0 to 199

Example:

Jump to Program Buffer location 10 if digital input #5 is High “1”.

@16 162 -5 1 10 (CR)

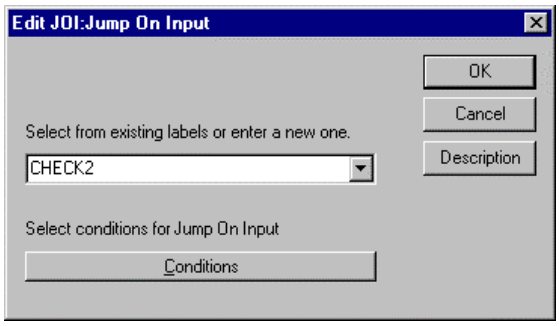
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



JUMP ON REGISTER EQUAL (JRE)

Description:

The **Jump On Register Equal** command allows looping and other conditional branching inside a program based on the comparison of the contents of the given register with the value of the compare parameter.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Jump On Register Equal (JRE)	Program (Class "E")	137 (0x89) [5 Words]	<Register>	0 to 40, 200 to 211
			<<Value>>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)
			<Program Buffer Location>	0 to 199

Example:

Jump to Program Buffer location 10 if Register # 32 contains "1200"

@16 137 32 1200 10 (CR)

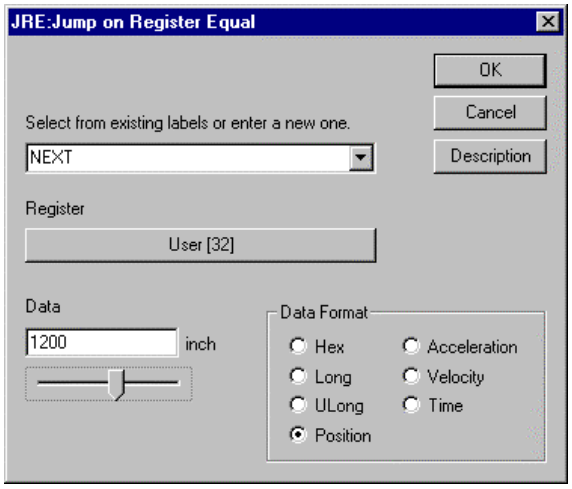
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Load Program (LPR)

Description:

The **Load Program** transfers a program from the non-volatile memory to the Program Buffer. The number of words to be transferred is read from the location given in the **NV Memory Address** parameter. This count is automatically stored in the first word, along with a checksum, when the program is written into non-volatile memory.

The content in the first **NV Memory Address** of the program is the Length in words of the program size and the Checksum of the program. The first command is read from the address following the Length & Checksum word, with subsequent words transferred up to the size indicated in the Length.

During the load process, the data is used to calculate a Checksum value. When the load is complete, the calculated Checksum is compared to the stored Checksum. If the Checksums do not agree **Bit #14** in the **Polling Status Word** is set ("1") to indicate a Program load failure.

This command only transfers the **Program** into the **Program Buffer**; it does not cause execution to begin. Once loaded into the **Program Buffer** a **Run Program** command must be issued to begin program execution. The program will remain in the buffer until removed by the **Clear Buffer** command or over loaded by another **Load Program** command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Load Program (LPR)	Immediate (Class "B")	14 (0x0E)	< NV Memory Address >	0 to 3839 (0 to 0x0EFF)
			< Count > The Count is typically set to "0"	**0** = use count stored at first address location. **1 to 199** = read the literal word count.

Example:

Load the program stored at NV Memory Address #110.

@16 14 110 0 (CR)

QuickControl Example

Immediate (Host) Mode Command Only

SilverMax Response:

ACK only

Response Example:

***10 (CR)**

LOAD AND RUN PROGRAM (LRP)

Description:

The **Load and Run Program** transfers a program from the non-volatile memory to the **Program Buffer** and once loaded, the program is executed. This command combines the function of the **Load Program** and the **Run Program** together in one command. The **Load and Run Program** is designed to be placed inside of programs to enable branching off to other programs stored in NV memory.

The content in the first **NV Memory Address** of the program is the Length in words of the program size and the Checksum of the program. The first command is read from the address following the Length & Checksum word, with subsequent words transferred up to the size indicated in the Length.

During the load process, the data is used to calculate a Checksum value. When the load is complete, the calculated Checksum is compared to the stored Checksum. If the Checksums do not agree, **Bit #14** in the **Polling Status Word** is set ("1") to indicate a program load failure. (This may occur if data and/or programs overlap their usage in non-volatile memory.)

After a load is complete and no errors were encountered, a **Run Program** will be initiated starting the program and dropping SilverMax into the **Program Mode**. Programs that contain errors will shut down the motor and exit execution when an error is encountered. Bit #12 (Program errors) of the **Polling Status Word** will be set indicating program execution error.

The program will remain in the buffer until removed by the **Clear Buffer** command or over loaded by another **Load Program** command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range(Hex)
Load And Run Program (LRP)	Program (Class "D")	156 (0x9C) [2 Words]	<NV Memory Address >	0 to 3839 (0 to 0x0EFF)

Example:

Load and Run the Program stored at NV Memory Address #150.

@16 156 150 (CR)

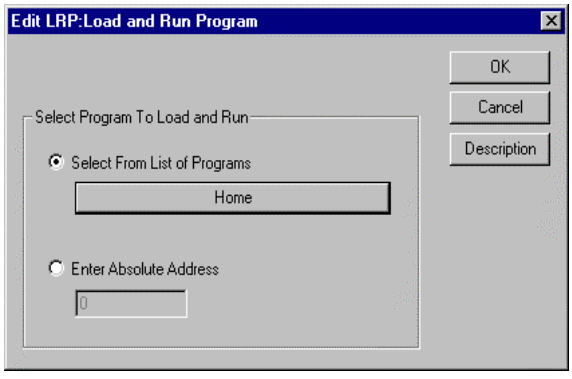
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PROGRAM CALL (PCL)

Description:

The **Program Call** command works the same as the **Jump** command except the next command location is stored for a **Program Return**. This works similar to a GOSUB in the programming language BASIC.

When this command is executed, the Program Buffer location of the next command is stored in an internal register. When a **Program Return** command is executed, the program will **Jump** back to the location that was stored.

Only one **Program Call** can be executed at one time (no nested routines). If a second **Program Call** is executed before a **Program Return** the program will error, **Stop** execution and **Bit #12** in the **Polling Status Word** will be set.

See the **Jump** command above for details on using this command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Program Call (PCL)	Program (Class "D")	201 (0xC9) [4 Words]	< Program Buffer Location>	0 to 199
			<Condition Enable>	0 to 65535 (0 to 0xFFFF)
			<Condition State>	0 to 65535 (0 to 0xFFFF)

Example:

Call Program Buffer location #50 if digital input #1 is High "1".

@16 201 50 16 16 (CR)

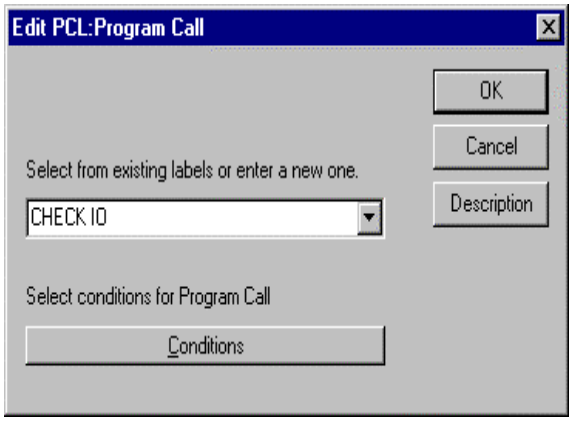
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PROGRAM CALL ON INPUT (PCI)

Description:

The **Program Call on Input** command works the same as the **Jump on Input** command except the next command location is stored for a program return. This works similar to a GOSUB in the programming language BASIC.

When this command is executed the **Program Buffer** location of the next command is stored in an internal register. When a **Program Return** command is executed, the program will **Jump** back to the location that was stored.

Only one **Program Call on Input** can be executed at one time (no nested routines). If a second **Program Call on Input** is executed before a **Program Return** the program will error, **Stop** execution and **Bit #12** in the **Polling Status Word** will be set.

See the **Jump on Input** command above for details on using this command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Program Call On Input (PCI)	Program (Class "D")	201 (0xC9) [4 Words]	< Program Buffer Location>	0 to 199
			<I/O Bit Enable>	-1 TO -14
			<I/O Bit State>	0 or 1

Example:

Call Program Buffer location #50 if digital input #2 is High "1".

@16 201 50 -2 1 (CR)

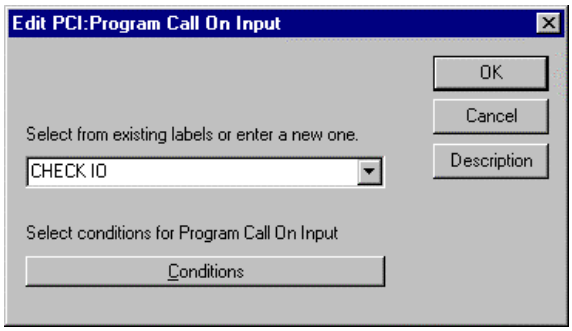
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PROGRAM RETURN (PRT)

Description:

The **Program Return** command is used as a complement to the **Program Call** command. When a Program Call has been executed, the buffer location of the next program command is stored in an internal register. When a **Program Return** is executed, a jump will occur to the stored program location.

If a **Program Return** is executed without a previous program called, the program will error, **Stop** execution and set **Bit #12** in the **Polling Status Word**.

Program Return can be set up to conditionally execute using the **Internal Status Word**. This works identical to the **Program Call** and **Jump** commands.

Placing a "0" in both parameters will cause an unconditional return.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Program Return (PRT)	Program (Class "D")	202 (0xCA) [3 Words]	<Condition Enable>	0 to 65535 (0 to 0xFFFF)
			<Condition State>	0 to 65535 (0 to 0xFFFF)

Example:

Return from Call if the last I/O #1 is High.

@16 202 16 16 (CR)

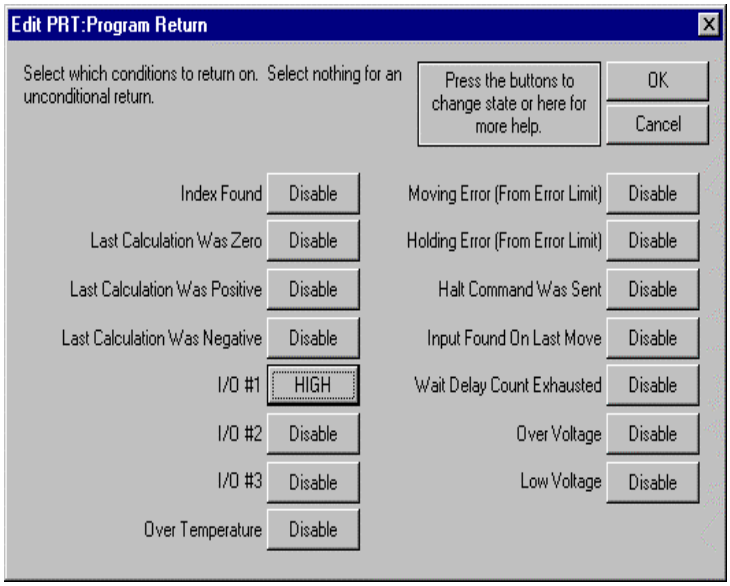
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



PROGRAM RETURN ON INPUT (PRI)

Description:

The **Program Return on Input** command is used as a complement to the **Program Call on Input** command. When a **Program Call** has been executed, the buffer location of the next program command is stored in an internal register. When a **Program Return** is executed, a **Jump** will occur to the stored program location.

If a **Program Return on Input** is executed without a previous program called, the program will error, **Stop** execution and set **Bit #12** in the **Polling Status Word**.

Program Return on Input can be set up to conditionally execute using the **Digital Inputs**. This works identical to the **Program Call on Input** and **Jump on Input** commands.

Placing a "0" in both parameters will cause an unconditional return.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Program Return On Input (PRI)	Program (Class "D")	202 (0xCA) [3 Words]	<I/O Bit Enable>	-1 to -14
			<I/O Bit State>	0 or 1

Example:

Return from Call if the Input #1 is Low ("0").

@16 202 -7 0 (CR)

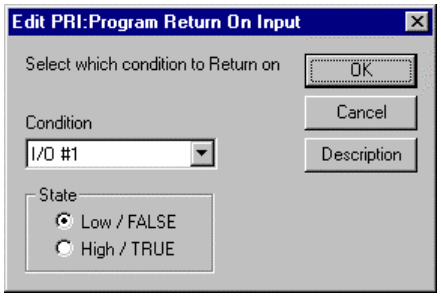
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Run Program (RUN)

Description:

Executes the program that has been previously loaded into the **Program Buffer**. This command will clear the download mode, set the program pointer to "0" and start the program.

The **Program Buffer** can be filled using the **Start Download** command from the Host controller (see **Start Download** below). It can also be filled using the **Load Program** command that will move a program from the non-volatile memory into the **Program Buffer** (see **Load Program** above).

Any **Command** or **Program** remaining in the Program Buffer can be executed over again using this command. A **Stop** command will stop the program but not clear the buffer. (Note that an immediate mode change velocity *will* overwrite the start of the buffer!) When in Host Mode **Program Type** commands sent to the SilverMax will remain in the buffer until another **Program Type** command is sent or a **Program** is loaded. The **Run Program** command can be used to repeat the previous **Program Type** command.

Sending this command while a **Program** or **Command** is executing will give a SilverMax **NAK – Busy** response.

Programs that contain errors will shut down the motor and exit execution when an error is encountered. Bit #12 (Program Errors) of the **Polling Status Word** will be set indicating program execution error.

NOTE: Sending a **Program Type** command while in Host mode actually loads that command into the start of the command buffer with an **END** command inserted behind it and then that (short) program is run.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Run Program (RUN)	Immediate (Class "C")	10 (0x0A)	NONE	NONE

Example:

Run the Program or Command that was previously loaded into the Program Buffer.

@16 10 (CR)

QuickControl Example:

Immediate (Host) Command Only

SilverMax Response:

ACK only

Response Example:

***10 (CR)**

Start Download (SDL)

Description:

This command puts SilverMax into a program download mode. **Program Type** commands that are sent after a **Start Download** command are automatically appended to the **Program Buffer** rather than being executed. Once in the **Program Buffer**, they can be executed as a program or stored to non-volatile memory. The program download mode is terminated by a **Store Program**, a **Run Program** or a **Clear Program** command.

Immediate Type commands sent to the SilverMax when in download mode are not appended to the buffer. Depending on the command, it will be immediately executed or it will cause an error.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Start Download (SDL)	Immediate (Class "B")	9 (0x9)	NONE	NONE

Example:

Put SilverMax into the program download mode.

@16 9 (CR)

QuickControl Example:

Immediate (Host) Command Only

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

Store Program (SPR)

Description:

The **Store Program** command stores a program into **Non-volatile Memory** onboard the SilverMax unit. The currently loaded program will be stored at the address number indicated in the address parameter of the command. A program must be downloaded in the **Program Buffer** before the **Store Program** is used. The program download mode is terminated by this command.

The length of the program (in words) and a Checksum are written to the indicated memory address, followed by the program. The length is used by the **Load Program** or **Load & Run Program** command to know the size of the program to load from **Non-volatile Memory**. Because the length is written to the first address location, add 1 word to overall length for keeping track of memory usage. The Checksum is used by the **Load Program** or **Load & Run Program** command to determine the data integrity. This prevents corrupted or partially overlapping programs from attempting execution.

This command leaves a background routine running until the programming of the non-volatile memory has completed. Once completed, **Bit #15** in the **Polling Status Word** is set. **Bit #14** is set if the command attempts to write beyond the allowed memory space. Execution time of this command varies depending on the number of words written.

It is recommended that the **Poll** command be used to check **Bit #15** of the **Polling Status Word** for completion.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Store Program (SPR)	Immediate (Class "C")	13 (0x0D)	< NV Memory Address >	0 to 3839 (0 to 0x0EFF)

Example:

Store the currently loaded program into NV memory at address 1000.

@16 13 1000 (CR)

QuickControl Example:

Immediate (Host) Command Only

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

WAIT ON BIT EDGE (WBE)

Description:

During program execution, the **Wait on Bit Edge** command causes SilverMax to Wait until an input condition is true. This is a very fast input check that is done every servo cycle (120microseconds). Placing this command in a program will cause the program to wait on the current line until the input condition is met. There is no wait limit; therefore, this can put SilverMax into an endless wait state.

The I/O bit condition is Edge triggered. The input must transition from **High to Low** for the **Falling** and **Low to High** for the **Rising** condition to be true.

Input Code	Input Source	Description
1	External	I/O #1
2	"	I/O #2
3	"	I/O #3
4	"	I/O #4
5	"	I/O #5
6	"	I/O #6
7	"	I/O #7
8	"	Current Index Sensor
9	"	Internal Index Sensor
10	"	External Index Sensor
11	Internal Status	Moving Error Status
12	"	Holding Error Status
13	"	Trajectory Generator Active
14	"	Delay Counter Active

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
wait on bit edge (WBE)	Program (Class "D")	204 (0xCC) [3 Words]	<Input Code>	1 to 14
			<Input Transition>	0 = falling (High to Low) 1 = rising (Low to High)

Example:

Cause program to wait until I/O #1 goes from Low to High.

@16 204 1 1 (CR)

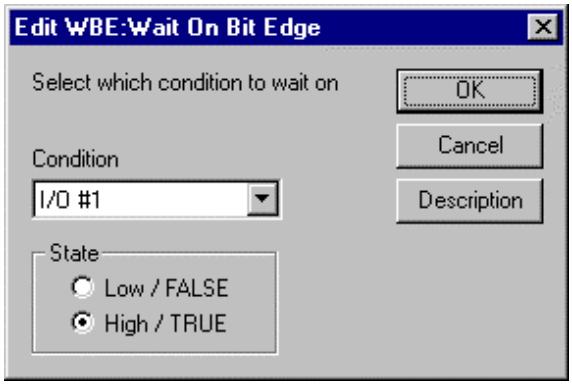
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



WAIT ON BIT STATE (WBS)

Description:

During program execution, the **Wait on Bit State** command causes SilverMax to Wait until an input condition is true. This is a very fast input check that done every servo cycle (120microseconds). Placing this command in a program will cause the program to wait on the current line until the input condition is met. There is no wait limit; therefore, this can put SilverMax into an endless wait state.

The I/O bit condition is State triggered, if the condition is true when the command is encountered no waiting will occur.

Input Code	Input Source	Description
1	External	I/O #1
2	"	I/O #2
3	"	I/O #3
4	"	I/O #4
5	"	I/O #5
6	"	I/O #6
7	"	I/O #7
8	"	Current Index Sensor
9	"	Internal Index Sensor
10	"	External Index Sensor
11	Internal Status	Moving Error Status
12	"	Holding Error Status
13	"	Trajectory Generator Active
14	"	Delay Counter Active

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range(Hex)
Wait On Bit State (WBS)	Program (Class "D")	194 (0xC2) [3 Words]	<Input Code>	1 to 14
			<Input State>	0 = "Low" 1 = "High"

Example:

Cause program to wait until I/O #1 is Low.

@16 194 1 0 (CR)

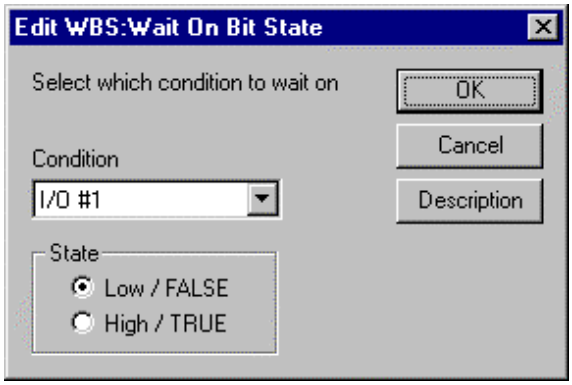
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



WAIT DELAY (WDL)

Description:

The **Wait Delay** command waits until the **Delay Counter** has decremented all the way to zero. Once it has reached zero, this command is exited and the next command in the Program Buffer is executed.

The **Delay Counter** is initialized using the **Delay** command with a negative value parameter. This causes the counter to begin the count down to zero. When the count has expired the **Wait Delay** exits and allows the program to continue. (See **Delay** command above for more details.) The Delay counter may also be written with any of the Register manipulation commands, either from the Serial Interface or from the program.

This command is useful when a timer needs to be set before a series of other commands are executed with a wait at the end. This allows a program or sub-routine to execute with precise timing.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
WAIT DELAY (WDL)	Immediate (Class "D")	141 (0x8D) [1 Word]	NONE	NONE

Example:

Cause program to wait until Delay Count is expired.

@16 141 (CR)

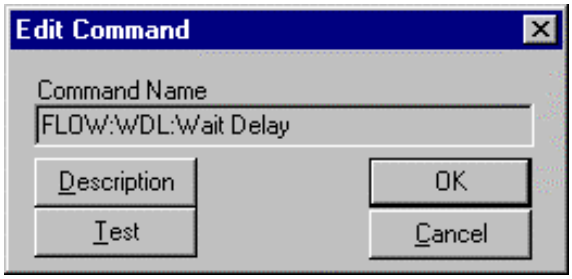
SilverMax Response:

ACK only

Response Example:

***10 (CR)**

QuickControl Example:



I/O Commands

ANALOG CONTINUOUS READ (ACR)

Description:

The **Analog Continuous Read** does continuous read of a selected **Analog Channel** into a **User Data Register**. Readings are taken every servo cycle (120 usec.) and transferred into the selected Data Register. A number of different Analog channels are available with this command.

There are four analog inputs that can be used to input data into the SilverMax. Analog inputs are designed to accept 0 to 5 Volts. For inputs that require ±5 volt or ±10 volt operation, external offsetting and scaling is required.

The internal **Analog to Digital Converter** (ADC) is a 10-bit version, which yields approximately 0.005 volts per ADC count. SilverMax filters (5 millisecond) the inputs and scales them up to a 15-bit value (32 counts = 0.005 volts), but the resolution remains the same. Note that the maximum reading corresponds to 32*1023 = 32736.

Analog inputs can be used in a single ended or differential manner. With differential usage, two analog inputs are used at one time (Such as Channels #5 & #6). This method reduces common mode noise (same noise on both inputs) from the input source. The difference of the two channels is used, thus the output range is +/- 32736.

Other types of data can be collected using the **Analog Continuous Read**. The **Input Power Supply** voltage and **Internal Temperature** can both be read into a **Data Register**. This information can be used for program conditional control or for direct read out to a Host controller.

Selecting Analog Channel "0" **disables** the **Analog Continuous Read**.

(See "**Using Analog Inputs**" in the **SilverMax User Manual** for more information)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Analog Continuous Read (ACR)	Program (Class "D")	207 (0xCF) [3 Words]	<Analog Channel #>	0 = (Disable) 1 = Analog #1 2 = Analog #2 3 = Analog #3 4 = Analog #4 5 = Analog #1 and Analog #2 6 = Analog #3 and Analog #4 7 = V+ (non-calibrated) 8 = Temperature (ADC counts)
			<Data Register>	10 to 40

ANALOG CONTINUOUS READ (ACR)

Example:

Configure Analog input #4 to do a continuous read to Data Register #26.

@16 207 4 26 (CR)

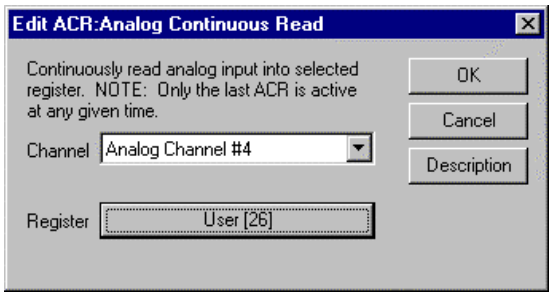
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



ANALOG READ INPUT (ARI)

Description:

The **Analog Read Input** does a single read of a selected **Analog Channel** into a **User Data Register**. A reading is taken only once and transferred into the selected Data Register. A number of Analog channels are available as above with the continuous read and include an extra channel (#9) for reading in a scaling factor for the Input Voltage.

There are four analog inputs that can be used to input data into the SilverMax. Analog inputs are designed to accept 0 to 5 Volts. For inputs that require ±5 volt or ±10 volt operation, external offsetting and scaling is required.

The internal **Analog to Digital Converter** (ADC) is a 10-bit version, which yields approximately 0.005 volts per ADC count. SilverMax filters (5 millisecond) the inputs and scales them up to a 15-bit value (32 counts = 0.005 volts), but the resolution remains the same. Note that the maximum reading corresponds to 32*1023 = 32736.

Analog inputs can be used in a single ended or differential manner. With differential usage, two analog inputs are used at one time (Such as Channels #5 & #6). This method reduces common mode noise (same noise on both inputs) from the input source. The difference of the two channels is used, thus the output range is +/- 32736.

Other types of data can be collected using the **Analog Continuous Read**. The **Input Power Supply** voltage and **Internal Temperature** can both be read into a **Data Register**. This information can be used for program conditional control or for direct read out to a Host controller.

(See **Using Analog Inputs** in the **SilverMax User Manual** for more information.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Analog Read Input (ARI)	Program (Class "D")	193 (0xC1) [3 Words]	<Analog Channel #>	1 = Analog #1 2 = Analog #2 3 = Analog #3 4 = Analog #4 5 = Analog #1 and Analog #2 6 = Analog #3 and Analog #4 7 = V+ (non-calibrated) 8 = Temperature (ADC counts) 9 = V+ scale factor
			<Data Register>	10 to 40

ANALOG READ INPUT (ARI)

Example:

Read into data register #10 the V+ input voltage.

@16 193 7 10 (CR)

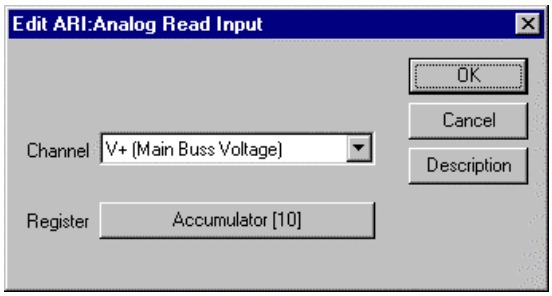
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



CONFIGURE I/O (CIO)

Description:

Configures the selected digital I/O bit for Input or Output. When setting as an Output the logic level state is also set. Each I/O bit is individually set using this command, the power-up default is all I/O bits are inputs. This prevents I/O conflicts.

Care must be taken when configuring I/O. If the I/O inputs #4, #5, #6 or #7 are being used as Analog Inputs (#1, #2, #3 or #4), setting these I/O bits to output mode will override Analog input.

SilverMax I/O are TTL compatible input and output. The outputs can source 8 milliamps and sink 8 milliamps.

When using digital I/O in a system where they may be connected to other controllers or PLCs, it is recommended that Optical-isolators be used. I/O connected directly to switches or sensors may not require isolation, according to user system grounding design.

A +5 Volt power supply output is available on SilverMax to power sensing devices. This output can supply 100 milliamps maximum. This output should never be driven.

Outputs that are in use for a Modulo output, View encoder, or a Done bit may not simultaneously be employed as bit I/O. Attempting to will generate a Sequence Error and shut down the program. See **Using SilverMax I/O** in the **SilverMax User Manual** for more information on I/O usage and conflicts.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Configure I/O (CIO)	Program (Class "D")	188 (0xBC) [3 Words]	<I/O Line #>	1 to 7
			<Setting>	-1 = Input 0 = Clear (Low) 1 = Set (High)

Example:

Set I/O bit #3 as output "Low".

@16 188 3 0 (CR)

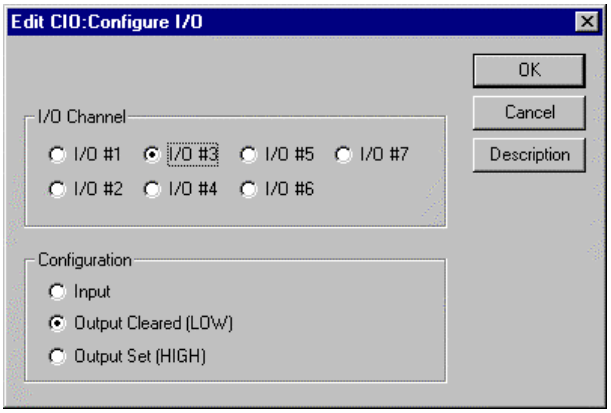
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



CLEAR OUTPUT BIT (COB)

Description:

Clears the selected Digital I/O bit to a logic Low ("0") condition (Output = 0 volts). If the I/O was configured as an input this will reconfigure the bit as an output and clear it to logic Low ("0").

SilverMax I/O are TTL compatible input and output. The outputs can source 8 milliamps and sink 8 milliamps. The I/O are voltage protected to eliminate failure from accidental over-voltage.

When using digital I/O in a system where they may be connected to other controllers or PLCs, it is recommended that Optical-isolators be used. I/O connected directly to switches or sensors may not require isolation.

Outputs that are in use for a Modulo output, View encoder, or a Done bit may not simultaneously be employed as bit I/O. Attempting to will generate a Sequence Error and shut down the program. See **Using SilverMax I/O** in the **SilverMax User Manual** for more information on I/O usage and conflicts.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Clear Output Bit (COB)	Program (Class "D")	206 (0xCE) [2 Words]	<I/O Line #>	1 to 7

Example:

Clear I/O bit #1 to a low ("0") state.

@16 206 1 (CR)

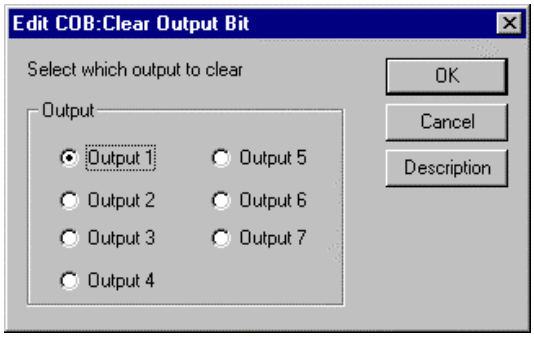
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



DISABLE ENCODER MONITOR (DEM)

Description:

Turns off the **Enable Encode Monitor** mode. If the **Enable Encode Monitor** mode was set this command will take it out of the monitor mode and return the **Digital I/O** to normal operation. (See **Enable Encode Monitor** below for more details.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Disable Encoder Monitor (DEM)	Program (Class "D")	171 (0xAB) [1 Word]	NONE	NONE

Example:

Turn off monitoring of the Internal Encoder.

@16 171 (CR)

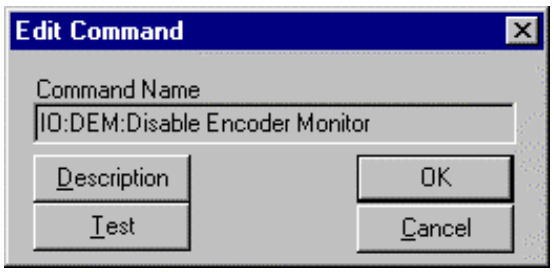
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



ENABLE ENCODER MONITOR (EEM)

Description:

The **Enable Encoder Monitor** command is used to output the SilverMax **Internal Encoder** signals to the **Digital I/O**. It causes a buffered copy of the raw encoder signals to be output to three digital lines for external viewing. The **Encoder A** signal is output to I/O line #1, the **Encoder B** signal to I/O bit line #2 and the **Encoder Index** signal is output to I/O line #3.

These signals have the same output specifications as the generic digital outputs. I/O lines #1, #2, and #3 are not available in Bit Output mode (either set or clear) while the encoder outputs are enabled. Similarly, the Encoder outputs may not be enables while any of the three I/O lines are in output mode. Either of these conflicts will cause a Sequence error and will terminate the program. See **Using SilverMax I/O** in the **SilverMax User Manual** for more information on I/O usage and conflicts.

To exit this mode, use the **DISABLE ENCODER MONITOR** command.

For using the Encoder output for controlling or sending signals to other external devices see the **Modulo** commands below. These commands are designed to be more flexible in outputting encoder signals.

Command Info:

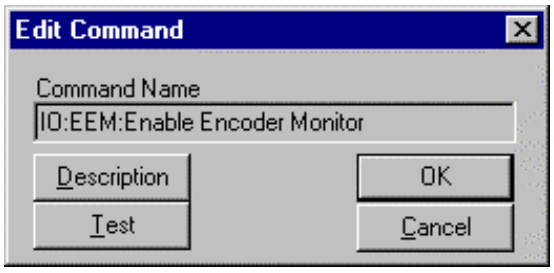
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Enable Encoder Monitor (EEM)	Program (Class "D")	170 (0xAA) [1 Word]	NONE	NONE

Example:

Turn on monitoring of the Internal Encoder.

@16 170 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

MODULO CLEAR (MDC)

Description:

The **Modulo Clear** takes SilverMax out of modulo output mode and frees up Digital I/O bits #6 & #7 for normal usage.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Modulo Clear (MDC)	Program (Class "D")	190 (0xBE) [1 Words]	NONE	NONE

Example:

Turn off modulo output.

@16 190 (CR)

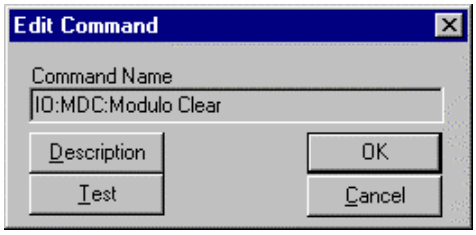
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



MODULO SET (MDS)

Description:

The **Modulo Set** command is used to enable, select the source, divisor, and format of the Modulo Outputs. These outputs make use Digital I/O bits #6 & #7 (See I/O Configuration Chart), and require that these bits to be configured as Inputs before issuing this command.

Either the Internal or an External encoder may be selected as the source for modulo output. This allows the modulo counter to be used with external sources.

The output can be configured in three different ways: 1) A/B quadrature, which is the normal output mode for an encoder, 2) Step up & Step Down, which gives a square wave output on I/O bit #6 when the encoder is counting positive or on I/O bit #7 when the encoder is counting negative, and 3) Step and Direction, which gives a square wave output on I/O bit #6 and a Direction output on I/O bit #7.

The Count sets up a divider that is the Modulo Count. In Step output modes, the square wave rate equals the encoder rate divided by the count.

To exit this mode, use the **Modulo Clear** command.

(See **Using SilverMax I/O** in the **SilverMax User Manual** for more information on modulo usage.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Modulo Set (MDS)	Program (Class "D")	189 (0xBD) [4 Words]	<Count>	1 to 256 (External)
			<Encoder Source>	0 = Internal 1 = External
			<Output Format>	0 = A/B Quad 1 = Step Up/Dn 2 = Step & Dir

Example:

Divide internal encoder counts by 50 and output in A/B Quadrate format.

@16 189 50 0 (CR)

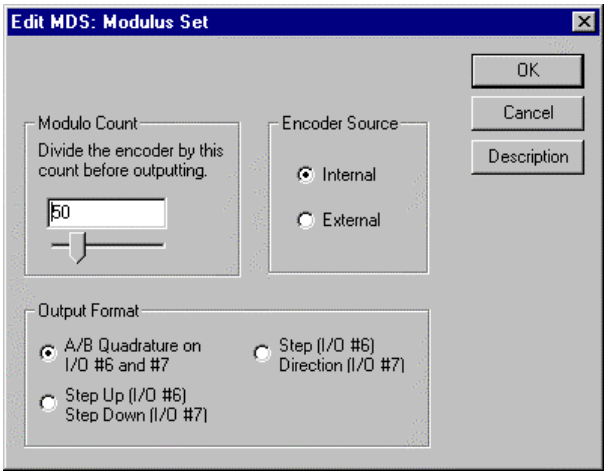
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



MODULO TRIGGER (MDT)

Description:

The **Modulo Trigger** allows digital I/O #1 to act as a gating or triggering signal.

Trigger mode #0 disables modulo output until I/O #1 goes from logic Low ("0") to High ("1"). Mode #1 enables modulo output for continuous operation. Mode #2 will gate the modulo output whenever I/O #1 is high ("1").

Mode #0 is edge triggered and can be used to as a one shot trigger. Mode #2 is used as a one shot reset for mode #0. Mode #0 is set up by first going into mode #2. If I/O #1 is low, this will disable modulo output, which resets the one shot. Mode #0 can now be set and will wait until I/O #1 goes from Low to High before enabling modulo output.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Modulo Trigger (MDT)	Program (Class "D")	191 (0xBF) [2 Words]	<Trigger Mode>	**0** = Disable until I/O #1 is High **1** = Enable **2** = Gate modulo using I/O #1

Example:

Enable continuous modulo output.

@16 191 1 (CR)

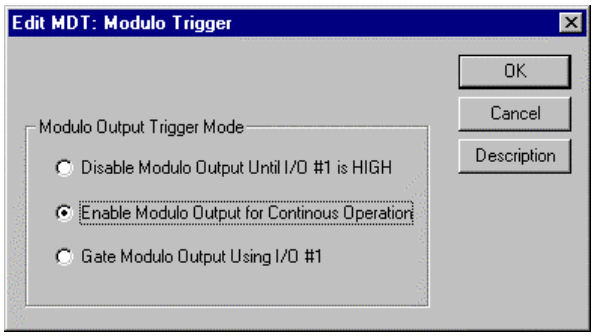
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



POSITION COMPARE (PCP)

Description:

Causes **I/O #1** to toggle its state when the motor position is equal to or greater than (absolute value) the "Position" value contained in the first of two **User Data Registers**. The I/O #1 state will toggle again when the motor position is greater than the "Modulo"(second **Data Register**) of the "Position" value. On a compare, if **I/O #1** is a logic Low ("0") it will be set to a High ("1"). If **I/O #1** is a logic High ("1") it will be set to a Low ("0"). **I/O #1** must be set to "Output" mode using the **Set Output Bit**, **Clear Output Bit** or the **Configure I/O** commands.

The First Data Register = "Position"
The Second Data Register = "Modulo"

The first **Data Register** contains the "Position" value that starts the compare process and executes the first toggle. The second **Data Register** contains the "Modulo" value used for creating a continuous toggle of the output. After the first position compare, the "Modulo" value is added to the "Position" value to set up for the next compare. This will continue until the **Position Compare** is disabled (Setting values to "0") or the motion completes. If the "Modulo" value is "0" only a single compare takes place.

Position Compare can be done in both positive and negative position moves. The "Modulo" is added as an absolute value to the "Position".

This command is accomplished using a software compare (updated every 120 usec.) and therefore may have a small delay of 120 microseconds from a compare to the actual **I/O #1** change of state.

Command Info:

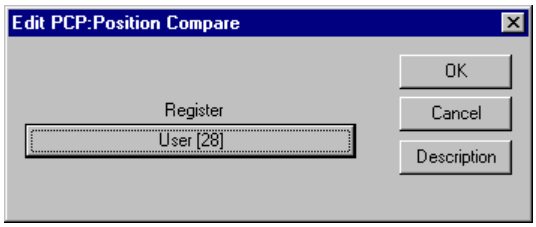
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Position Compare (PCP)	Program (Class "D")	245 (0xBF) [2 Words]	<Starting User Data Register>	**0** = Disable Usage 10 to 40

Example:

Enable Position Compare using Data Register #28 for the Position compare value and #29 for the Modulo value.

@16 245 28 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

SET OUTPUT BIT (SOB)

See Also: **COB**

Description:

Sets the selected Digital I/O bit to a logic High ("1") condition (Output = 5 volts). If the I/O was configured as an input this will reconfigure the bit as an output and set it to logic High ("1").

SilverMax I/O are TTL compatible input and output. The outputs can source 5 milliamps and sink 8 milliamps.

When using digital I/O in a system where they may be connected to other controllers or PLCs, it is recommended that Optical-isolators be used. I/O connected directly to switches or sensors may not require isolation.

Outputs that are in use for a Modulo output, View encoder, or a Done bit may not simultaneously be employed as bit I/O. Attempting to will generate a Sequence Error and shut down the program. See **Using SilverMax I/O** in the **SilverMax User Manual** for more information on I/O usage and conflicts.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	ParameterRange (Hex)
Set Output Bit (SOB)	Program (Class "D")	205 (0xCD) [2 Words]	<I/O Line #>	1 to 7

Example:

Set I/O bit #1 to a logic High ("1") state.

@16 205 1 (CR)

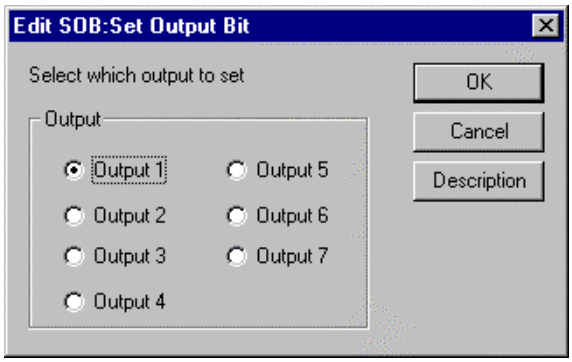
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Data Register Commands

A number of 32-bit Data Registers have been allocated for special purposes. Data Registers are used as data storage locations that may be used and modified by a Host controller or by SilverMax internal functions. They provide data storage for the distance and position parameters for **Register** motion profile commands. They can also be used by the **Calculation** command as data variables for more complex calculations, such as shortest paths for rotary motions. The **Input Modes** use data registers for **Offset** and **Scaling** factors.

Data Register Commands

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The first 10 data registers are dedicated read only. The next 15 registers are optionally dedicated or user defined, they are Read/Write registers. The last 16 registers are for **User Defined Data** usage, they are also Read/Write registers. The data registers are detailed below:

Dedicated Data Registers (Typically Read Only)

These registers are dedicated to the functions listed. They are updated internally every servo cycle (120 microseconds) and are available for reading by a Host controller using the **Read Register** command. Exceptions to the **Read Only** status are Data Registers #0 and #1 (Target & Position) and Data Registers #2 and #4 (Last Index Position & Last Input Position). By using the **Calculation** command, the contents of Data Register #0 and #1 can be modified. Data Register #2 and #4 can be directly modified using the **Write Register** commands.

Reg. #	Type	Description
0	R/W*	Current Target value: (Requested Position)
1	R/W	Current Position: (Actual Position)
2	R/W	Last Index Position: Position of last detected index pulse
3	R	Internal Status Word (upper word) Current Process State (lower word)
4	R/W	Last Input Position: Position when last input was found:
5	R/W	Delay counter value: Ticks left on the **DELAY** counter
6	R	Max Error value (upper word) Most recent Error value (lower word)
7	R	Once filtered Velocity (upper word) Twice filtered Velocity (lower word)
8	R	Integrator value
9	R	Loop State (upper word) Motor Torque (lower word)
200	R/W	Current External Encoder Position
201	R/W	Last External Encoder Index Position
202		Reserved
203		Reserved
204	R	Trajectory Acceleration
205	R	Trajectory Velocity
206	R/W	Closed loop Hold torque (upper word) Closed loop Run torque (lower word)
207	R/W	Open loop Hold torque (upper word) Open loop Run Torque (lower word)
208	R/W	Moving error Limit (upper word) Stopped error Limit (lower word)
209	R	Sense Mask (Default Direction)
210	R	Size of command buffer (upper word) Start of command buffer (lower word)
211	R/W	Kill Motor trigger bits (upper word) trigger state (lower word)

R = Read Only
R/W = Read and Write
R/W* = Read and Write (Write using **CALCULATION**: Offset Target/Position command)

NOTE: Care must be taken when writing to the R/W Data Registers, they can affect the operation of the motor.

User or Dedicated Data Registers (Read/Write)

These registers are by default **User Data Registers** that can be used by all commands that work with or on User Data Registers. However, when SilverMax is put into one of the **Input Modes** registers #12 to #18 are dedicated to the Input Mode functions. When **Profile Move** commands are used, registers #20 to #24 are dedicated to the move parameters. Register #10 is used by the **Calculation** command as an accumulator, but can be user-defined.

Reg. #	Description	Description when Dedicated	Commands that use Dedicated
10	User data	Accumulator	**CALCULATION**
11	User data		
12	User data	Input Source Data	***INPUT MODE**
13	User data	Input Offset	***INPUT MODE**
14	User data	Input Dead band	***INPUT MODE**
15	User data	Maximum Scale/Limit	***INPUT MODE**
16	User data	Maximum Output Scale	***INPUT MODE**
17	User data	Output Offset	***INPUT MODE**
18	User data	Output Rate of Change Limit	***INPUT MODE**
19	User data		
20	User data	Absolute Position	***PROFILE MOVE**
21	User data	Acceleration	***PROFILE MOVE**
22	User data	Velocity	***PROFILE MOVE**
23	User data	Deceleration	***PROFILE MOVE**
24	User data	Offset	***PROFILE MOVE**
25-40	User data		

***Input Mode** includes **Position Input Mode**
Velocity Input Mode
Torque Input Mode

***Profile Move** includes **Profile Move**
Profile Move Continuous
Profile Move Override
Profile Move Exit

Data Registers Detailed Descriptions

These registers can be used by all commands that are able to operate on or with **User Data Registers**.

25 to 40: User data

206/207: provide an alternate way to set the motor torque from the Serial Interface, or from within a program. These may be altered while a motion is in progress if multitasking has been enabled.

208: provides an alternate way to set the error limits from the Serial Interface, or from within a program. These may be altered while a motion is in progress if multitasking has been enabled.

211: May be used to determine which bit in which state triggered an Kill Motor operation. These registers are written internally whenever the Kill Motor operation is triggered. They may be overwritten to zero to make conditional testing of a triggering event easier.

ADD TO REGISTER (ATR)

Description:

The **Add to Register** command adds the included data into the selected 32 bit **Data Register**. This command is similar to the **Write Register** commands except it is designed to add to the existing value instead of overwriting it. The data parameter is "signed" so that a negative value can be added, which works as subtraction for decrementing.

This command is very useful when using **Data Registers** for counters by allowing an increment or decrement of greater than "1".

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Add To Register (ATR)	Program (Class "D")	248 (0x9A) [4 Words]	< Data Register >	10 to 40
			<< Data to Add >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)

Example:

Add the number "1.5 SEC." to data register #10.

@16 248 10 12500 (CR)

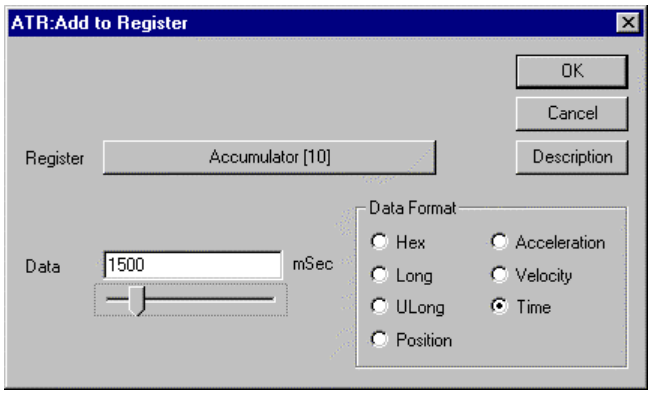
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



REGISTER LOAD MULTIPLE (RLM)

Description:

Loads an array of data from the selected **Non-Volatile Memory** address to an array of **Data Registers**. A Checksum value is verified to insure good data.

During the load process, the data is used to calculate a Checksum value. When the load is complete, the calculated Checksum is compared to the stored Checksum. If the Checksums do not agree bits #14 & #12 in the **Polling Status Word** are set ("1") to indicate a register load failure.

Data is loaded from **Non-Volatile Memory** sequentially. It is put into the **Data Registers** also sequentially starting with the selected register.

The **Number of Registers** must be the same as the Length of data stored. If the parameters are incorrect or out of range, bits #14 & #12 of the **Polling Status Word** are set. Care should be taken to keep track of data stored into **NV Memory** to avoid **Data Register** loading problems and to avoid overwriting of programs or other data stored in the NV memory. In addition to two words for each register stored, a word containing the count and checksum information, and a word of "0" are prepended to the register data. The zero prevents accidental execution of the data as a program by triggering the END command.

INDIRECT ADDRESSING: The **Non-Volatile Memory** may be indirectly addressed by putting the wanted address into Register # 10, and then using a NV Memory Address of zero. The zero address triggers the indirect addressing mode, as location "0" is reserved as the start of the initialization program. This may be used to recall a long series of numbers from NV memory via a loop operation.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Register Load Multiple (RLM)	Program (Class "D")	197 (0xC5) [4 Words]	<Number of Registers>	1 to 10
			<Starting Data Register>	10 to 40 & 200 to 211
			<NV Memory Address>	0 to 3839 (0 to 0x0EFF)

Example:

Sequentially Load 5 data registers starting at #16 with the data from NV memory address 1000

@16 197 5 16 1000 (CR)

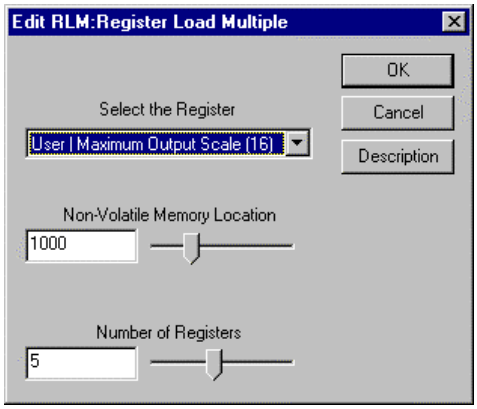
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



REGISTER LOAD NON-VOLATILE (RLN)

Description:

Loads data from the selected **Non-Volatile Memory** address into the selected **Data Register**. A Checksum value is verified to insure good data.

The loading process is the same as used by the **Register Load Multiple** with only one register being loaded. The data selected must be stored using the **Register Load Non-Volatile** or the **Register Load Multiple** using "1" for the **Number of Registers**.

The **Number of Registers** must be the same as the Length of data stored. If the parameters are incorrect or out of range, bits #14 & #12 of the **Polling Status Word** are set. Care should be taken to keep track of data stored into **NV Memory** to avoid **Data Register** loading problems. Two additional memory locations are stored for each block of numbers stored, the first word holds a count and checksum value, the second holds a zero to indicate data block rather than program block. Additionally, each register stored requires 2 words of storage.

INDIRECT ADDRESSING: The **Non-Volatile Memory** may be indirectly addressed by putting the wanted address into Register # 10, and then using a NV Memory Address of zero. The zero address triggers the indirect addressing mode, as location "0" is reserved as the start of the initialization program. This may be used to recall a long series of numbers from NV memory via a loop operation.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Register Load Non-Volatile (RLN)	Program (Class "D")	199 (0xC7) [3 Words]	<Data Register>	10 to 40 & 200 to 211
			<NV Memory Address>	0 to 3839 (0 to 0x0EFF)

Example:

Load data register #12 with data from NV memory address 1000.

@16 199 12 1000 (CR)

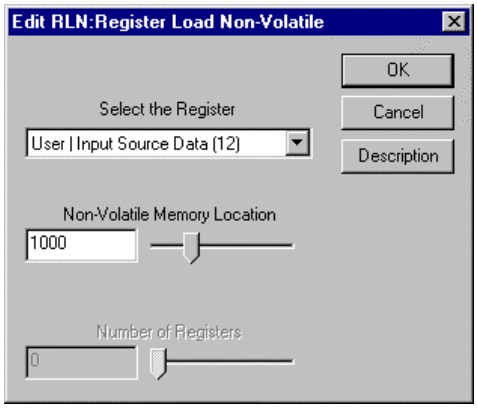
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Read Register (RRG)

Description:

The **Read Register** command reads back data from a selected **32-Bit Data Register** using the **Serial Interface**. Since it is an **Immediate Type,** this command can be used at any time, even during program execution. Any **Data Register** can be read back using this command including registers #0 through #40 & #200 through #211.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Read Register (RRG)	Immediate (Class "A")	12 (0x0C)	<Data Register>	0 to 40 & 200 to 211

Example:

Read back the motor's current position.

@16 12 1 (CR)

QuickControl Example:

Immediate (Host) Command Only

SilverMax Response:

Data Register data

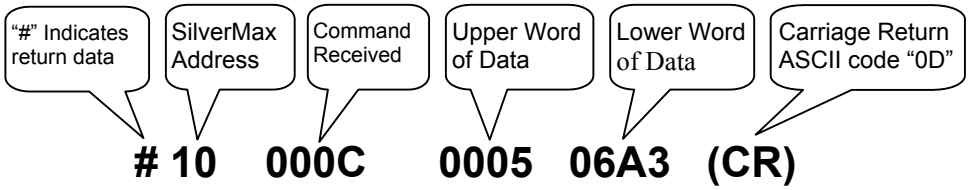
Response Example:

Example: Read Register command that requests the "Current Position" from SilverMax #16 (which is "10" in Hexadecimal); the last 8 digits represent the 32-bits of position data.

The current position = 329,379 in decimal

 # 10 000C 0005 06A3 (CR)

The return data breaks down as follows:



REGISTER STORE MULTIPLE (RSM)

Description:

Stores data from an array of **Data Registers** to the selected **NV Memory** address. A Checksum value is calculated from the array and stored with the array. Data from the selected **Data Registers** is stored sequentially to **NV Memory**. Data is also copied from the **Data Registers** sequentially.

The Length of the array and a Checksum are combined and written to the first **NV Memory Address**, followed by a "0" then the array of data. The length is used by the **Register Load Multiple** command to know the size of the array to load from **Non-volatile Memory**. The Checksum is used by the **Register Load Multiple** command to determine the data integrity. This prevents the loading of bad data that could cause erratic operation. The "0" prevents an array of data from being executed as a program.

Memory Map in Words	
Length N (Upper Byte)	Checksum (Lower Byte)
0	
Register X Upper Word	
Register X Lower Word	
Register X+1 Upper Word	
Register X+2 Lower Word	
…	
Register X+N-1 Upper Word	
Register X+N-1 Lower Word	

This command writes 2 Words of data for each **Data Register**, a Word for the Length/Checksum and a Word for a "0" placed between the Length/Checksum and the data array.

Example: Storing 7 **Data Registers** takes up 16 Words of **NV Memory**.

This command leaves a background routine running until the storing in the non-volatile memory has completed. Once completed, bit #15 in the **Polling Status Word** is set. Bit #14 is set if the command attempts to write beyond the allowed memory space. Execution time of this command varies depending on the number of words written. Worst case time is approximately 10mS per 32 word block or portion of a block (on 32 word boundaries) of memory written.

INDIRECT ADDRESSING: The **Non-Volatile Memory** may be indirectly addressed by putting the wanted address into Register # 10, and then using a NV Memory Address of zero. The zero address triggers the indirect addressing mode, as location "0" is reserved as the start of the initialization program. This may be used to recall a long series of numbers from NV memory via a loop operation.

NOTE: If a rapidly changing data register is stored to **NV Memory**, the data has the possibility of being inaccurate. This is due to the write cycle of the SilverMax DSP. The cycle performs two 16 bit writes from the 32 bit data register to NV Memory. If the "data" in the register changes before the second 16 bit write cycle, then it will be incorrect. It is advisable to copy the data from the changing register to a second register and then storing the second register to **NV Memory**.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Register Store Multiple (RSM)	Program (Class "D")	196 (0xC4) [4 Words]	<Number of Registers>	1 to 10
			<Starting Data Register>	0 to 40 & 200 to 211
			<NV Memory Address>	0 to 3839 (0 to 0x0EFF)

Example:

Store 5 data registers starting at #20 to NV memory starting at address 2500

@16 196 5 20 2500 (CR

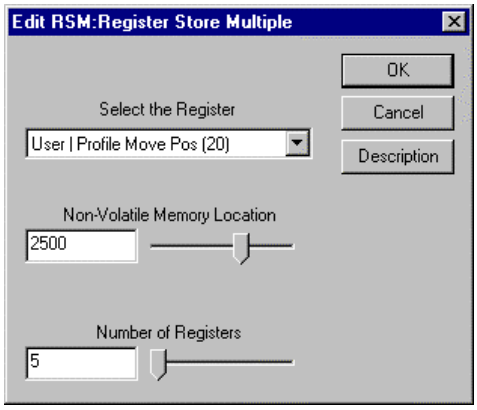
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



REGISTER STORE NON-VOLATILE (RSN)

Description:

Stores data from a **Data Register** to the selected **Non-Volatile Memory** address. A Checksum value is calculated from the data and stored with the data.

The storing process is the same as used by the **Register Store Multiple** with only one register being stored. The data selected may be loaded using the **Register Load Non-Volatile** or the **Register Load Multiple** using "1" for the **Number of Registers**.

This command writes 2 Words of data for the **Data Register**, a Word for the Length/Checksum and a Word for a "0" placed between the Length/Checksum and the data array. Storing one **Data Register** takes up 4 Words of **NV Memory**.

See command **Register Store Multiple (RSM)** for more details.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Register Store Non-Volatile (RSN)	Program (Class "D")	198 (0xC6) [3 Words]	<Data Register>	0 to 40 & 200 to 211
			<NV Memory Address>	0 to 3839 (0 to 0x0EFF)

Example:

Store data register #1 to NV memory address 1612.

@16 198 1 1612 (CR)

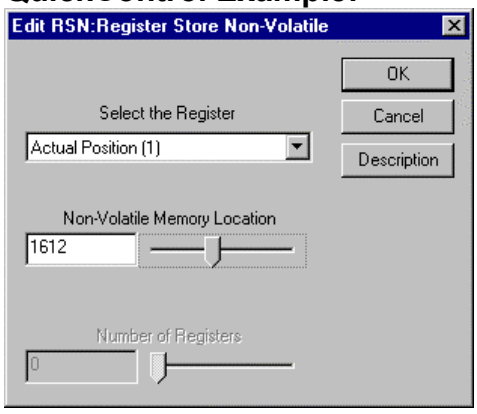
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Write Register, Immediate Type (WRI)

Description:

The **Write Register** command writes the included data into the selected 32 bit Data Register. Using the **Serial Interface** this command can be used at any time, even during program execution. The **Data Register** can be used for parameter data by commands such as **Register Move Absolute, Velocity Based** or **Calculation**.

This command is very useful for dynamically modifying SilverMax operation using a Host interface. For example, to move to a machine dependent alignment position, the following steps would be used. First, the output shaft would be positioned to the desired location, and the numeric position would be determined by executing a **Read Register** from Data Register #1 (Current Position). This value would then be written to a **User Data Register** using either **Write Register, Immediate Type** (using serial interface), **Calculation** or **Write Register, Program Type** (from within a program). Next, when it is desired to move the motor to that position, the **Register Move Absolute, Velocity Based** command could be used with the number of the **User Data Register** to which the data was stored.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Write Register, Immediate Type (WRI)	Immediate (Class "A")	11 (0x0B)	<Data Register >	10 to 40 (0x0A to 0x28)
			<<Data >>	0 to 4,294,967,295 (0 to 0xFFFFFFFF) or -2,147,483,648 to +2,147,483,647

Example:

Write the number "8000" to data register #12.

@16 11 12 8000 (CR)

SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:

Immediate (Host) Command Only

See pages 11-12 for details.

WRITE REGISTER, PROGRAM TYPE (WRP)

Description:

The **Write Register** command writes the included data into the selected 32-bit Data Register. This command is similar to **Write Register, Immediate Type** except it is designed to be embedded in a program and cannot be use through the Serial Interface while a command or program is being executed. The **Data Register** can be used for parameter data by commands such as **Register Move Absolute, Velocity Based** or **Calculation**.

This command allows **32-Bit Data** to be stored in a program and used by SilverMax for a variety of purposes including the **Register** motion profile commands.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Write Register, Program Type (WRP)	Program (Class "D")	154 (0x9A) [4 Words]	< Data Register >	10 to 40
			<< Data >>	0 to 4,294,967,295 (0 to 0xFFFFFFFF)

Example:

Write the number "1" to data register #10.

@16 154 10 1 (CR

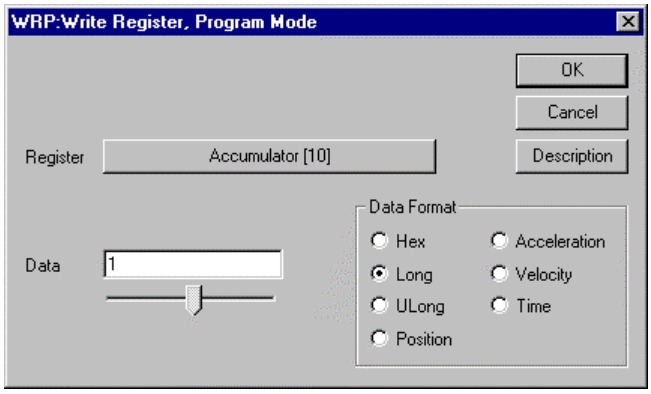
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



WRITE CMD LONG WORD (WCL)

Description:

This command allows program space starting at the selected command buffer location to be overwritten with the 32 bit data in the selected register. This allows for self modification of the command parameters within the command buffer to all any of the command parameters to be dynamically modified within the program. This command specifically is intended to modify 32 bit parameters. Extreme care should be used when writing any self modifying code to prevent unwanted outcomes. The QuickControl tool has support for this command, which simplifies its application, and enforces consistency checks. However, values being transferred are dynamic, based on the contents of the selected register; the range of the data is ***not*** verified at transfer, so undesired results may be obtained if out of range parameters are assembled into the command buffer, including Sequence Error shutdowns. This command does allow for great flexibility by allowing any of the parameters to be made register based.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Write Cmd Long Word (WCL)	Program (Class "D")	138 (0X8A) [3 Words]	<Register> 0 to 40, 200 to 211	(0 to 0x28, 0xC8 to 0xD3)
			<CMD Buffer Location>	0 to 199 (0x0 to 0xC7)

Example:

Overwrites the Command Buffer contents at locations 122 and 123 with the contents of Register #10.

@16 138 10 122 (CR)

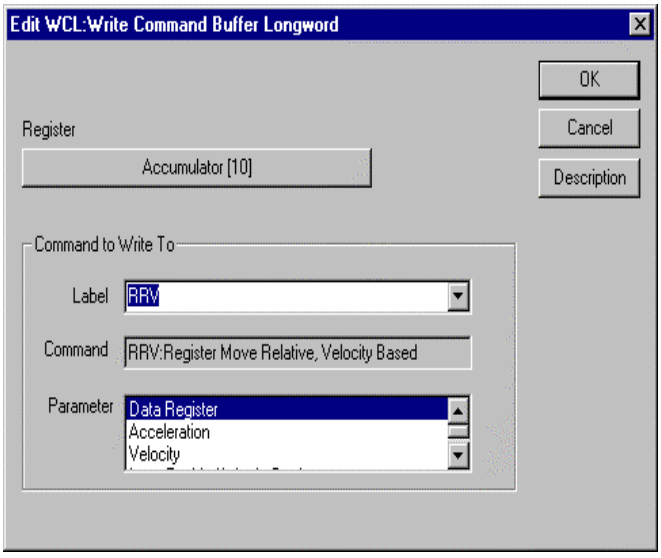
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



WRITE CMD WORD (WCW)

Description:

This command allows program space starting at the selected command buffer location to be overwritten with the lower word 16 bit data in the selected register. This allows for self modification of the command parameters within the command buffer to all any of the command parameters to be dynamically modified within the program. This command specifically is intended to modify 16 bit parameters. Extreme care should be used when writing any self modifying code to prevent unwanted outcomes. The QuickControl tool has support for this command, which simplifies its application, and enforces consistency checks. However, values being transferred are dynamic, based on the contents of the selected register; the range of the data is ***not*** verified at transfer, so undesired results may be obtained if out of range parameters are assembled into the command buffer, including Sequence Error shutdowns. This command does allow for great flexibility by allowing any of the parameters to be made register based.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Write Cmd Long Word (WCL)	Program (Class "D")	139 (0X8B) [3 Words]	<Register> 0 to 40, 200 to 211	(0 to 0x28, 0xC8 to 0xD3)
			<CMD Buffer Location>	0 to 199 (0x0 to 0xC7)

Example:

Overwrites the Command Buffer contents at locations 122 with the contents of the lower word of Register #10.

@16 138 10 122 (CR)

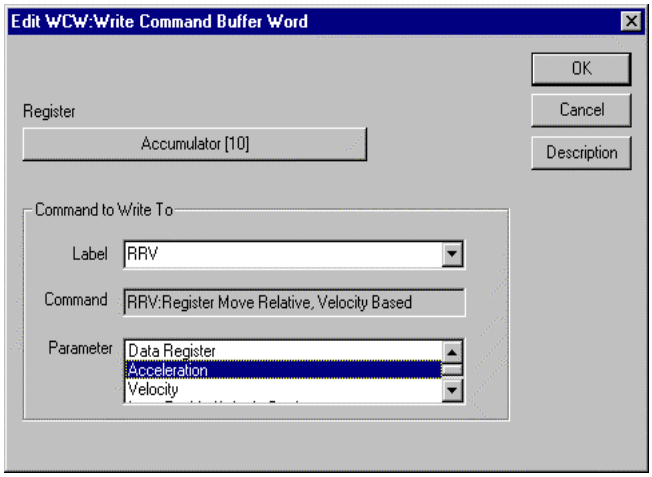
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Misc. Commands

CLEAR MAX ERROR (CME)

Description:

The **Maximum Error** (absolute value of the **Position Error**) is updated and latched each servo cycle. The value is limited to a single word, saturating at 32767 (0x7FF) as a maximum value. This command allows the **Maximum Error** value to be reset to zero so that the **Maximum Error** for a new motion profile may be determined.

The **Maximum Error** value is stored in a **Dedicated Data Register** and may be read using the **Read Register** command.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Clear Max Error (CME)	Program (Class "D")	147 (0x93) [1 Word]	NONE	NONE

Example:

Clear the Maximum Error value.

@16 147 (CR)

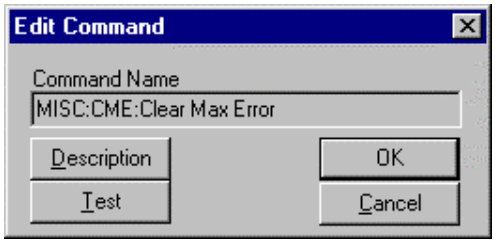
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



CLEAR INTERNAL STATUS (CIS)

Description:

The **Internal Status Word** is used to indicate different conditions or states in SilverMax. Several of the conditions are "latched" and therefore are persistent even after the condition has changed. The **Clear Internal Status** command is used to clear the latched conditions in the **Internal Status Word**.

This command should be used after a **Kill Motor** condition has occurred before normal operation can be restored.

This command is particularly useful for resetting the **Holding Error** and **Moving Error** bits so new errors can be detected.

The **Internal Status Word** is copied into a **Dedicated Data Register** and can be read by a Host controller using the **Read Register** Command. (See **Data Register Commands** for more details.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Clear Internal Status (CIS)	Program (Class "D")	163 (0xA3) [1 Word]	NONE	NONE

Example:

Clear the Internal Status Word.

@16 163 (CR)

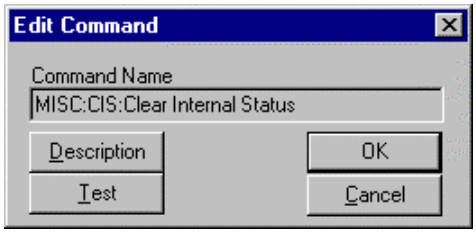
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



CHECK INTERNAL STATUS (CKS)

Description:

This command checks the conditions of the **Internal Status Word** in the same manner as does the **Jump** command. If the condition enabled is true, bit #6 of the **Polling Status** is set to "1". A zero in the **Condition Enable** parameter unconditionally sets bit #6 of the **Polling Status Word**.

This command may be used to convey information from a program executing back to the host processor that is **polling** the SilverMax.

The **Internal Status Word** is copied into a **Dedicated Data Register** and can be read directly by a Host controller using the **Read Register** Command. (See **Data Register Commands** for more details.)

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Check Internal Status (CKS)	Program (Class "D")	164 (0xA4) [3 Words]	<Condition Enable>	0 to 65535 (0 to 0xFFFF)
			< Condition State >	0 to 65535 (0 to 0xFFFF)

Example:

Check for a Last Calculation Was Positive and report to Host using Polling Status Word.

@16 164 4 4 (CR)

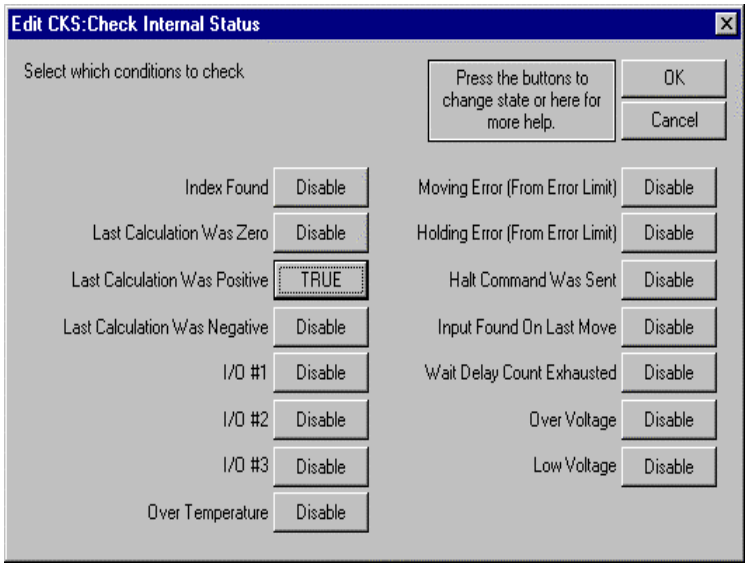
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



TARGET TO POSITION (TTP)

Description:

This command copies the current **Position** value into the **Target** register. This is useful for removing errors when an obstruction is encountered without losing track of position. This allows the next motion to move and ramp as expected rather than having to unwind the accumulated error. This is useful for homing against a hard stop where error is intentionally introduced, and for removing error before enabling the motor drivers after they have been disabled.

The **Target** value is updated by the **Trajectory Generator**, the **Step & Direction** mode or one of the **Input Modes**. The SilverMax servo loop uses the Target value as the input position parameter. If the motor is unable to achieve the Target position windup will occur. This command removes the windup error.

Command Info:

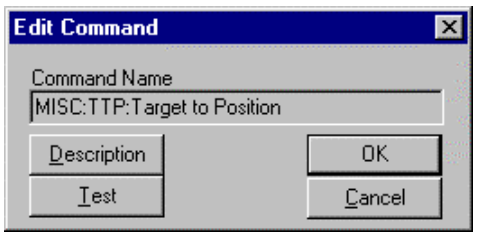
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Set Target To Position (TTP)	Program (Class "D")	146 (0x92) [1 Word]	NONE	NONE

Example:

Sets the Target to the current position.

@16 146 (CR)

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

ZERO TARGET (ZTG)

Description:

This command zeros the **Target** register. Before doing this, the current **Position Error** (Target – Position) is copied into the **Position Register**. This is useful for homing routines to denote the current location as "Zero" so that all other locations can be defined as an offset from "Zero".

This command does not remove any windup, whatever **Position Error** exists before this command will remain. To zero the **Target** and clear the **Position Error** use the **Zero Target & Position** command.

Command Info:

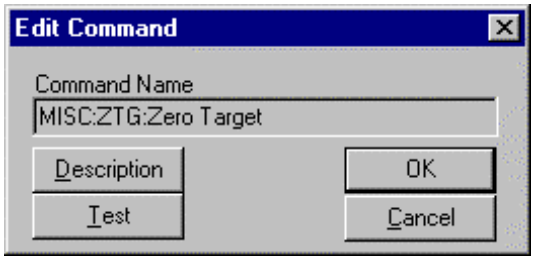
Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Zero Target (ZTG)	Program (Class "D")	144 (0x90) [1 Word]	NONE	NONE

Example:

Sets the Target to zero ("0") does not clear the position error.

@16 144 (CR

QuickControl Example:



SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

ZERO TARGET & POSITION (ZTP)

Description:

This command zeros the **Target** register and the **Position** register. This command zeros out both registers and removes any **Position Error** that may exist. This is useful for homing routines to denote the current location as "Zero" so that all other locations can be defined as an offset from "Zero".

This command removes any Windup that may exist from a previous motion.

Command Info:

Command Name	Command Type	Command Code (Hex)	Command Parameters	Parameter Range (Hex)
Zero Target & Position (ZTP)	Program (Class "D")	145 (0x91) [1 Word]	NONE	NONE

Example:

Sets the Target & Position to zero ("0").

@16 145 (CR

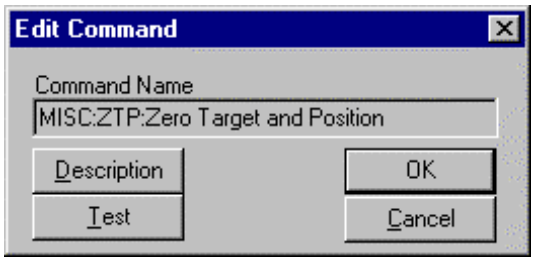
SilverMax Response:

ACK only

Response Example:

*** 10 (CR)**

QuickControl Example:



Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

SUMMARY OF SILVERMAX COMMANDS:

Status Commands

Clear Poll (CPL) (Type A)	1 (0x1)	< Status Word >	0 to 65535 (0 to 0xFFFF)	ACK only	Clear out the indicated bits in the **Polling Status Word**.
Poll (POL) (Type A)	0 (0x0) or No Command	NONE	NONE	ACK Or **Polling Status Word**	Return the **Polling Status Word** if any new status condition has occurred, otherwise it sends an ACK.
Read I/O States (RIO) (Type A)	21 (0x15)	NONE	NONE	2 Bytes	Read the current states of the I/O bits. Also reads other bit information.
Read Internal Status Word (RIS) (Type A)	20 (0x14)	NONE	NONE	2 Bytes	Read the Internal Status Word.
Read Program Buffer (RPB) (Type A)	6 (0x6)	< Length >	1 to 8 (1 to 0x08)	< Length > < Data >…	Read the number of words indicated by the **Length** from the indicated **Address** in the **Program Buffer**.
		< Buffer Address >	0 to 199 (0 to 0x00C7)		
Revision (RVN) (Type A)	5 (0x05)	NONE	NONE	8 Bytes of Return Data	Returns the revision date of this code, and the buffer sizes.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

Override Commands

Halt (HLT) (Type A)	2 (0x2)	NONE	NONE	ACK only	Immediately stops the motion/block in progress. Disables the motor.
Restart (RST) (Type A)	4 (0x4)	NONE	NONE	No response (No ACK)	Jump to location zero and restart the processor. No response is given.
Single Step Exit (SSE) (Class F)	18 (0x12)	NONE	NONE	ACK only	Exits the single step mode. Halt, Stop, Motor Kill , Power Low will also cause the exit of single step mode
Single Step Program (SSP) (Class F)	17 (0x11)	NONE	NONE	ACK only	Puts SilverMax into a program single step mode or executes next line a program if already in single step mode.
Stop (STP) (Type A)	3 (0x3)	<<deceleration >>	**-1** = Stop Immediate or **0** = Stop using previous Acceleration or **1 to 536,870,911** (1 to 0x1FFFFFFF)	ACK only	Does a stop of the current motion/block.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

Initialization Commands

ACK DELAY (ADL) (Class D) (Factory default = 0 for RS-232 15 for RS-485)	173 (0xAD [2 Words]	< Count >	0 to 21845 (0 to 0x5555)	ACK only	This command sets a time delay for waiting to send an ACK or data after a command has been received. (120usec per count) . Non "0" in RS-232 Serial mode enables "RS-232 Multi-drop"
ANTI-HUNT CONSTANTS (AHC) (Class D) (Factory Default = 0, 0)	150 (0x96) [3 Words]	< Out of Anti-Hunt error > Open => Closed	0 to 35 (0 to 0x23)	ACK only	Sets the Anti-Hunt transfer constants. Typical values for these would be 10 and 4 (decimal). Making both zero disables the anti-hunt mode.
		< Into Anti -Hunt error> Closed => Open	-35 to 35 (0 to 0x35 & 0xFFFF to 0xFFDD)		
ANTI-HUNT DELAY (AHD) (Class "D")	230 (0xE6) [2 Words]	< Count in Ticks > 1 Tick = 120usec.	0 to 65535 (0 to 0xFFFF)	ACK only	The Anti-Hunt Delay sets up a time delay from when a motion is complete to when the Anti-Hunt is allowed.
ANTI-HUNT MODE (AHM) (Class "D" (Factory Default= 0)	219 (0xDB) [2 Words]	<Mode> 0=Anti-Hunt only when stopped 1=Anti-Hunt stopped or moving	0 to 1 (0 to 0x1)	ACK only	Anti-Hunt Mode allows Anti-Hunt to be active even while in motion as well as while at rest, rather than only active at rest.
BAUD RATE (BRT) (Class D) (Factory Default = 576) These numbers work for "E" series only	174 (0xAE) [2 Words]	< Speed >	3 = 300 12 = 1200 24 = 2400 48 = 4800 96 = 9600 192 = 19200 288 = 28800 384 = 38400 576 = 57600 1000 =100000 1152 =115200 2304 =230400	ACK only	Sets the serial communications baud rate. Defaults to 57600 if not set.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
CALIBRATE ANALOG INPUT FROM NV (CAI) (Class D)	211 (0xD3) [2 Words]	<NV Memory Address>	Factory Default Calibration = 65524 (0xFFF4)	ACK only	Sets the Analog Channel Calibration Factor and the Maximum over voltage shutdown voltage. The appropriate data is stored as a long word into location 65524 as a Factory Calibration.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
CONTROL CONSTANTS (CTC) (Class D) (Factory Defaults depend on motor type)	148 (0x94) [8 Words]	<Velocity 1 Feedback Gain>	0 to 32767 (0 to 0x7FFF)	ACK only	Sets the Servo Control Constants. Using Factory defaults will nominally work with inertial loads from 1:1 to 1:5 with a low compliance coupling. (See **SilverMax Servo Tuning** in the **SilverMax User Manual** for more information)
		<Velocity 2 Feedback Gain>	0 to 32767 (0 to 0x7FFF)		
		<Velocity Feedfoward Gain>	0 to 32767 (0 to 0x7FFF)		
		<Acceleration Feedback Gain>	0 to 32767 (0 to 0x7FFF)		
		<Acceleration Feedfoward Gain>	0 to 32767 (0 to 0x7FFF)		
		<Proportional Gain>	0 to 32767 (0 to 0x7FFF)		
		<Integrator Gain>	0 to 32767 (0 to 0x7FFF)		
DISABLE DONE BIT (DDB) (Class D) (THIS IS DEFAULT)	171 (0xAB) [1 Word]	NONE	NONE	ACK only	Clears "Done" usage of I/O Line #1
DIRECTION (DIR) (Class D) (Factory Default is "0" normal)	184 (0xB8) [2 Words]	<Selection>	0 = Normal (CW) 1 = Reverse	ACK only	This command allows selection of the motor direction at power-up. Direction is set as it relates to positive or negative numbers. By default, a positive number moves the motor Clockwise. This may only be set while the motor is in the open loop mode.
DUAL LOOP CONTROL (DLC) (Class "D")	243 (0xF3) [1 Word]	NONE	NONE	ACK only	Configures SilverMax to run in a "Dual Loop" control mode. In Dual Loop control the SilverMax servos its position based on an **External Encoder** signal. The target value is set to the present external encoder value to prevent jumping of the motor when changing modes. Note: the control parameters may need configuring when changing from single to dual or dual to single loop control.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
DISABLE MOTOR DRIVER (DMD) (Class "D")	228 (0xE4) [1 Word]	NONE	NONE	ACK only	Disables the motor driver and shorts the windings together. The SilverMax will be unable to move when attempting any motion command.
DISABLE MULTI-TASK (DMT) (Class "D")	226 (0xE2) [1 Word]	NONE	NONE	ACK only	Disables SilverMax "Multi-Tasking" operation.
ENABLE DONE HIGH (EDH) (Class D) (NOT DEFAULT)	251 (0xBB) [1 Word]	NONE	NONE	ACK only	Enables I/O line #1 to output a signal **High** ("1") when the SilverMax is done moving with no position error.
ENABLE DONE LOW (EDL) (Class D) (NOT DEFAULT)	187 (0xBB) [1 Word]	NONE	NONE	ACK only	Enables I/O line #1 to output a signal **Low** ("0") when the SilverMax is done moving with no position error.
ENABLE MOTOR DRIVER (EMD) (Class "D")	227 (0xE3) [1 Word]	NONE	NONE	ACK only	Enables the SilverMax motor driver. The driver is by default enabled.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
ENABLE MULTI-TASKING (EMT) (Class "D")	225 (0xE1) [1 Word]	NONE	NONE	ACK only	Enables SilverMax "Multi-Tasking" operation, which allows "Motion" while executing a program
ERROR LIMITS (ERL) (Class D) (Factory Default = 0, 0, 100)	151 (0x97) [4 Words]	< Moving limit >	-32768 to 32767 (0 to 0xFFFF)	ACK only	Sets error moving and holding error limits for status and motor shut down purposes. Sets the delay time after a movement until the motor uses hold currents and hold error limits. Also used for placing SilverMax into "Drag" mode.
		< Hold limit >	-32768 to 32767 (0 to 0xFFFF)		
		< Delay to Holding >	0 to 65535 (0 to FFFF)		
FILTER CONSTANTS (FLC) (Class D) (Factory Defaults depend on motor type)	169 (0xA9) [4 Words]	< Velocity 1 Feedback >	0 to 32767 (0 to 0x7FFF)	ACK only	Sets the Velocity and Acceleration Feedback filter constants. (See **SilverMax Servo Tuning** for more information)
		< Velocity 2 Feedback >	0 to 32767 (0 to 0x7FFF)		
		< Acceleration Feedback >	0 to 32767 (0 to 0x7FFF)		
GRAVITY OFFSET CONSTANT (GOC) (Class "D")	237 (0xED) [2 Words]	< Gravity Offset >	-32767 to 32767 (0 to 0x7FFF)	ACK only	Establishes a value that compensates for the effects of gravity on the load which the motor is driving.
IDENTITY (IDT) (Class D) (Factory Default = "16")	155 (0x9B) [2 Words]	< Group + Unit Identity > Group = Upper Byte Unit = Lower Byte	257 to 65278 (0x0101 to 0xFEFE)	ACK only	Changes the identity of the SilverMax. NOTE: Group Identifier is a broadcast address giving no ACK. Identifier is the unit address. If the Group Identifier is zero, it is ignored.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
KILL DISABLE DRIVER (KDD) (Class "D")	183 (0XB7) [1 Word]	NONE	NONE	ACK only	Disables the motor driver and shorts the windings together when a "**KILL MOTOR CONDITION**" is met.
KILL ENABLE DRIVER (KED) (Class "D")	182 (0xB6) [1 Word]	NONE	NONE	ACK only	Causes SilverMax to leave the motor drivers enabled when a "**KILL MOTOR CONDITION**" is met.
KILL MOTOR CONDITIONS (KMC) (Class D) (Factory Default is Kill on Over Temperature)	167 (0xA7) [3 Words]	<Condition Enable> <Condition State>	0 to 32767 (0 to 0x7FFF) 0 to 32767 (0 to 0x7FFF)	ACK only	Sets the conditions in the **Internal Status Word** that will disable the motor. Does a complete shut down of motor drivers.
KILL MOTOR RECOVERY (KMR) (Class D) (Factory Default is do nothing)	181 (0xB5) [2 Words]	<process>	0 = Do Nothing -1 = Jump to memory address 0 1 to 3839 = NV Memory address (1 to 0x0EFF)	ACK only	Sets up what happens after a Kill Motor Condition. Can do nothing, re-initialize the motor or jump to a user Program.
LOW VOLTAGE TRIP (LVT) (Class D) (Factory Default is "0" Don't Check)	212 (0xD4) [2 Words]	<Voltage>	0 = Don't Check 10 to 48 (1 to 0x30)	ACK only	Used in conjunction with the Power Loss Recovery command this command sets the input voltage that will trigger a "Low Voltage" status.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
MOTOR CONSTANTS (MCT) (Class D) (Factory Defaults depend on motor type and voltage)	168 (0xA8) [9 Words]	< MC1 >	0 to 32767 (0 to 0x7FFF)	ACK only	Sets the motor constants. These are motor type and power supply voltage dependent. Constants are set up by the Factory. Manually editing these constants may cause improper operation or failure of the motor. (This command settings are normally done using "**QuickControl**" Windows software. Contract factory for more details)
		< MC2 >	0 to 32767 (0 to 0x7FFF)		
		< MC3 >	0 to 32767 (0 to 0x7FFF)		
		< MC4 >	0 to 32767 (0 to 0x7FFF)		
		< MC5 >	0 to 32767 (0 to 0x7FFF)		
		< MC6 >	0 to 32767 (0 to 0x7FFF)		
		< MC7 >	0 to 32767 (0 to 0x7FFF)		
		< MC8 >	0 to 32767 (0 to 0x7FFF)		
MAXIMUM TEMPERATURE TRIP (MTT) (Class D) (Factory Default is "0" Don't Check)	214 (0xD6) [2 Words]	<Temperature>	0 = Don't Check 1 to 70 (1 to 0x46)	ACK only	Sets the temperature at which SilverMax will shut down the motor. This is used to prevent over-heating of the motor. Value is entered in integer units. (Example "70" for 70 degrees Celsius)
OPEN LOOP PHASE (OLP) (Class D)	152 (0x98) [2 Words]	< Angle in Counts >	-7 to 79 (0 to 0x004F & 0xFFF9 to FFFF)	ACK only	Sets the open loop phase angle. If negative, angle is in half steps. *** Angle must be < 4 Full steps. NOTE: Only use in open loop mode!
OVER VOLTAGE TRIP (OVT) (Class D) (Factory Default is "52" Volts)	213 (0xD5)	<Voltage>	1 to 53 (1 to 0x35)	ACK only	Sets the voltage at which SilverMax will cause a "Kill Motor". Mainly used to prevent over-voltage during deceleration. Value is entered in integer units (Example "48" for 48 volts). The "Kill Motor" routine is called if this occurs
PHASE ADV CONSTANTS (PAC) (Class D) (Factory Defaults depend on motor type and voltage)	172 (0xAC) [4 Words]	< P_adv >	0 to 15 (0 to 0x0F)	ACK only	Sets the motor phase constants. These are motor type and power supply dependent to optimize motor torque at high speed. Factory set for optimal performance.
		< P2_adv >	0 to 600 (0 to 0x0258)		
		< P_limit >	0 to 37 (0 to 0x25)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
POWER LOW RECOVERY (PLR) (Class D) (Factory Default is do nothing)	208 (0xD0) [2 words]	<Process>	0 = Do Nothing -1 = Restart 1 to 3839 = NV Memory address (1 to 0x0EFF)	ACK only	If the input voltage drops below a set value (See Low Voltage Trip) a user program can be called that can perform a power loss exit routine.
PROTOCOL (PRT) (Class D) (Factory Default is "1" 8-Bit)	185 (0xB9) [2 Words]	<Selection>	0 = 9-Bit 1 = 8-Bit	ACK only	Allows the user to select the desired communications protocol. 8-Bit ASCII is default.
S – CURVE FACTOR (SCF) (Class D) (Factory Default = "0" Trapezoidal)	195 (0xC3) [2 Words]	<Curve Shape>	0 = Trapezoidal 1 to 32766 = "S" Shape 32767 = Full "S"	ACK only	Using this command, the shape of the acceleration can be set from linear to full S-curve. All motion commands use the current setting. Can be re-set prior to a motion.
SELECT EXTERNAL ENCODER (SEE) (Class D) (Factory Default is "0" Falling, "0" I/O #6 "3" Use I/O #2 & 3	192 (0xC3) [4 Words]	<Index State> <Index Source> <Encoder Style>	0 = Falling 1= Rising 0 = I/O #6 1 = I/O #2 0 = A/B Quad 1 = Pulse Up/Dn 2 = Pulse & Dir 3 = Use I/O # 2 & 3	ACK only	Selects the desired input conditions for an external encoder. External encoders can be used by the "Pulse and Direction" commands. If an external encoder is not being used the inputs are ignored.
SERIAL INTERFACE (SIF) (Class D) (Factory Default is "1" RS485)	186 (0xBA) [2 Words]	<Selection>	0 = RS232 1 = RS485	ACK only	Allows the user to select the serial hardware interface. RS-485 is default.
SINGLE LOOP CONTROL (SLC) (Class "D")	244 (0xF4) [1 Words]	NONE	NONE	ACK only	Configures SilverMax to run in the standard "Single Loop" control mode. All SilverMax encoder information is derived from the **Internal Encoder**. The Target value is set to the internal encoder position (to prevent jumping when changing modes)

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
SOFT STOP LIMITS (SSL) (Class D)	221 (0xDD) [2 Words]	<Data Register> (First of two)	0 = Not Used 10 to 39	ACK only	Sets position limits for "End of Travel" control. Two **Data Registers** are used to store the end limits. Data must be stored in Registers using a **Write Register**.
TORQUE LIMITS (TQL) (Class D) (Factory Defaults depend on motor type)	149 (0x95) [5 Words]	<Closed Loop Holding>	0 to 32767 (0 to 0x7FFF)	ACK only	Sets the open loop and closed loop motor torque limits. For most motors A value of 20000 counts = 100% torque. 30000 counts = 150% torque. 150% torque can only be used for short bursts. See the SilverMax motor specification for the 100% torque value.
		<Closed Loop Moving>	0 to 32767 (0 to 0x7FFF)		
		<Open Loop Holding>	0 to 32767 (0 to 0x7FFF)		
		<Open Loop Moving>	0 to 32767 (0 to 0x7FFF)		
TORQUE RAMP UP (TRU) (Class D)	222 (0xDE) [3 Words]	<final value>	0 to 32767	ACK only	Ramps up the torque limit values by the increment given up to the final value. This is used mainly during motor initialization. Only Ramps up **Open Loop Torque Limits**.
		<increment>	1 to 32767		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

Mode Commands

GO CLOSED LOOP (GCL) (Class D)	142 (0x8E) [1 Word]	NONE	NONE	ACK only	Go into closed loop operation. Typically only done one time during initialization. Note that both the position and the target are set to zero (0).
GO OPEN LOOP (GOP) (Class D)	143 (0x8F) [1 Word]	NONE	NONE	ACK only	Go into open loop operation (This is the default start up state.)
POSITION INPUT MODE (PIM) (Class D) (Actually Target input)	216 (0xD8) [4 Words]	<Filter constant>	0 to 32767 (0 to 0x7FFF)	ACK only	Puts the SilverMax into a **Position** control mode. Uses the contents of the specified Data register for the position value. Sending any other mode or motion command exits this mode.
		<I/O Exit Enable>	0 to 65535 {–1 to –7} (0 to 0xFFFF)		
		<I/O Exit State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)		
REGISTERED STEP & DIRECTION (RSD) (Class "D")	223 (0xDF) [2 Words]	<User Data Register>	10 to 40 (0x0A to 0x28)	ACK only	This command works the same as the **Scaled Step and Direction** command except that the "scaling" value is found in a **User Data Register**.
SCALED STEP & DIRECTION (SSD) (Class D)	180 (0xB4) [2 Words]	<Scale Factor>	1 to 32767 (1 to 0x7FFF) 1024 is a multiplier of 1	ACK only	This works the same as **Step and Direction** but allows scaling of the input step count. 1024 is a scaling factor of 1.
VELOCITY INPUT MODE (VIM) (Class D)	217 (0xD9) [4 Words]	<Filter constant>	0 to 32767 (0 to 0x7FFF)	ACK only	Puts the SilverMax into a **Velocity** control mode. Uses the contents of the specified Data register for the velocity value. Sending any other mode or motion command exits this mode.
		<I/O Exit Enable>	0 to 65535 {–1 to –14} (0 to 0xFFFF)		
		<I/O Exit State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
Velocity Mode, Immediate Type (VMI) (Class A) Warning this will cause SilverMax to go into a velocity Mode !!	15 (0xF)	<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)	ACK only	Sets the motor to the indicated velocity using the given acceleration. If the motor is stopped, in a step/dir, or is doing a move, the present motion is halted, and the new velocity is set into the motor. Also stops a Program from executing NOTE: if the acceleration is negative, the accumulated error is removed and the absolute value of the acceleration is used.
		<< Velocity >>	-2,147,483,647to +2,147,483,647 (0 to 0xFFFFFFF) (0x80000000 to 0x7FFFFFFF)		
		< Stop Enable >	0 to 65,535 (0 to 0xFFFF)		
		< Stop State >	0 to 65,535 (0 to 0xFFFF)		
VELOCITY MODE, PROGRAM TYPE (VMP) (Class D)	159 (0x9F) [7 Words]	<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)	ACK only	Puts SilverMax in a Velocity mode (constant velocity move). If in a program execution stops. NOTE: the sign of the velocity sets the direction, the acceleration is unsigned (positive).
		<< Velocity >>	-2,147,483,647to +2,147,483,647 (0 to 0xFFFFFFF) (0x80000000 to 0x7FFFFFFF)		
		< Stop Enable >	0 to 65,535 (0 to 0xFFFF)		
		< Stop State >	0 to 65,535 (0 to 0xFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

Motion & Profile Move Commands

HARD STOP MOVE (HSM) (Class "D")	229 (0xE5) [1 Word]	NONE	NONE	ACK only	This command provides a way, while in **Multi-Tasking** operation, to execute a "Hard Stop" of any move or mode from within a program.
INTERP. MOVE START (IMS) (Class "D")	253 (0XFD) [1 Words]	NONE	NONE	ACK only	This command uses Register 17, 18, and 19 as well as 20-24 from the profiled move command. Register 17 holds a pointer to the first of 4 values. A parameter value of 0 enables the 4 deep interpolated move queue. A 1 is written to the upper half of register 17 when the data it points to have been used. If taking data from the queue, then the unit will wait for the initial data before execution. Register 18 is used internally to hold the remaining time, and register 19 holds the default deceleration to stop with if the next data is not present when needed.
INTERP MOVE QUEUE CLEAR (IMQ) (Class "D")	254 (0xFE) [1 Word]	NONE	NONE	ACK only	This command clears out the interpolated move queue leaving all 4 entries empty. See IMS and IMW for additional information.

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
INTERP. MOVE WRITE QUEUE (IMW) (immediate mode)	25 (0x19) (4 long parameters)	<<Time ticks>>	0 to 2,147,483,647 (0x0 to 0x7FFFFFFF)	ACK if accepted NAK FULL if no queue was full.	Write the 4 longword values to the Interpolated Move circular Queue if there is room. If the queue is full, then it will NAK FULL. See IMS and IMQ for additional information.
		<<position>>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)		
		<<acceleration>>	1 to 2,147,483,647 (0x1 to 0x7FFFFFFF)		
		<<velocity>>	0 to 2,147,483,647 (0x0 to 0x7FFFFFFF)		
MOVE ABSOLUTE, TIME BASED (MAT) (Class D)	176 (0xB0) [9 Words]	<< Position >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)	ACK only	Initiates an absolute position move using acceleration time & total move time as parameters. (Time Values are in ticks. A tick is equal to 120usec.)
		<< Acceleration Time >>	0 to 65534 (0 to 0xFFFE)		
		<< Total Time >>	2 to 2,147,483,647 (0x02 to 0x7FFFFFFF)		
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		
MOVE ABSOLUTE, VELOCITY BASED (MAV) (Class D)	134 (0x86) [9 Words]	<< Position >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)	ACK only	Initiates an absolute position move using Acceleration & Velocity parameters.
		<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)		
		<< Velocity >>	0 to 2,147,483,647 (0 to 0x7FFFFF)		
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
MOVE RELATIVE, TIME BASED (MRT) (Class D)	177 (0xB1) [9 Words]	<< Position >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)	ACK only	Initiates a relative distance move using acceleration time & total move time as parameters. (Time Values are in ticks. A tick is equal to 120usec.)
		<< Acceleration Time >>	0 to 65534 (0 to 0xFFFE)		
		<< Total Time >>	2 to 2,147,483,647 (0x02 to 0x7FFFFFFF)		
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		
MOVE RELATIVE, VELOCITY BASED (MRV) (Class D)	135 (0x87) [9 Words]	<< Distance >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)	ACK only	Initiates a relative distance move using Acceleration & Velocity parameters.
		<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)		
		<< Velocity >>	0 to 2,147,483,647 (0 to 0x7FFFFF)		
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		
PRE-CALCULATED GO (PCG) (Class "D")	231 (0xE7) [1 Word]	NONE	NONE	ACK only	After a **PRE-CALCULATE MOVE** command has been successfully executed, the **GO** command initiates the move, which will begin immediately (within 120 usec.).
PRE-CALCULATED MOVE (PCM) (Class "D")	232 (0xE8) [1 Word]	NONE	NONE	ACK only	Causes SilverMax to perform the "**Calculation task**" on a **Motion** command. The move does not begin until a "**GO**" is sent.
PROFILE MOVE CONTINUOUS (PMC) (Class "D")	240 (0xF0) [3 Words]	<Stop Enable>	0 to 65535 {–1 to –14} (0 to 0xFFFF)	ACK only	Puts SilverMax into a move that does not end unless explicitly commanded. During the move, any move parameter can be updated either by a Host or by an internal Program.
		<Stop State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
PROFILE MOVE OVERRIDE (PMO) (Class "D")	249 (0xF9) [3 Words]	<Stop Enable>	0 to 65535 {–1 to –14} (0 to 0xFFFF)	ACK only	Allows a **PROFILE MOVE CONTINOUS** to end when the "Position" is achieved.
		<Stop State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)		
PROFILE MOVE (PMV) (Class "D")	241 (0xF1) [3 Words]	<Stop Enable>	0 to 65535 {–1 to –14} (0 to 0xFFFF)	ACK only	Works identical to the **PROFILE MOVE CONTINOUS** except that when the "Position" is achieved the move ends (Stops and goes into position holding mode).
		<Stop State>	0 to 65535 { 1 or 0 } (0 to 0xFFFF)		
PROFILE MOVE EXIT (PMX) (Class "D")	242 (0xF2) [1 Word]	NONE	NONE	ACK only	Exits the current **Profile Move** allowing the move to stop using the "**Deceleration**" parameter stored in **Data Register #23**

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
REGISTER MOVE ABSOLUTE, TIME BASED (RAT) (Class D)	178 (0xB2) [9 Words]	<<Data Register >>	10 to 40	ACK only	Initiates an absolute position move using acceleration time & total move time as parameters. A **Data Register** is used for the **Position** parameter. (Time Values are in ticks. A tick is equal to 120usec.)
		<< Acceleration Time >>	0 to 65534 (0 to 0xFFFE)		
		<< Total Time >>	2 to 2,147,483,647 (0x02 to 0x7FFFFFFF)		
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		
REGISTER MOVE ABSOLUTE, VELOCITY BASED (RAV) (Class D)	160 (0xA0) [9 Words]	<<Data Register >>	10 to 40	ACK only	Initiates an absolute position move using Acceleration & Velocity parameters. A **Data Register** is used for the **Position** parameter.
		<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)		
		<< Velocity >>	0 to 2,147,483,647 (0 to 0x7FFFFF)		
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		
REGISTER MOVE RELATIVE, TIME BASED (RRT) (Class D)	179 (0xB3) [9 Words]	<<Data Register >>	10 to 40	ACK only	Initiates a relative distance move using acceleration time & total move time as parameters. A **Data Register** is used for the **Distance** parameter. (Time Values are in ticks. A tick is equal to 120usec.)
		<< Acceleration Time >>	0 to 65534 (0 to 0xFFFE)		
		<< Total Time >>	2 to 2,147,483,647 (0x02 to 0x7FFFFFFF)		
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
REGISTER MOVE RELATIVE, VELOCITY BASED (RRV) (Class D)	161 (0xA1) [9 Words]	<<Data Register >>	10 to 40	ACK only	Initiates a relative distance move using Acceleration & Velocity parameters. A **Data Register** is used for the **Distance** parameter.
		<< Acceleration >>	1 to 1,073,741,823 (1 to 0x3FFFFFFF)		
		<< Velocity >>	0 to 2,147,483,647 (0 to 0x7FFFFF)		
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		
EXTENDED REGISTER MOVE ABSOLUTE, TIME BASED (XAT) (Class "D")	236 (0xEC) [4 Words]	<<Starting Data Register >>	10 to 40	ACK only	Performs an absolute position move using move parameters contained in the indicated **User Data Registers**. This command works like the basic **Move Absolute, Time Based (MAT)** command in all other ways.
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		
EXTENDED REGISTER MOVE ABSOLUTE, VELOCITY BASED (XAV) (Class "D")	234 (0xEA) [4 Words]	<<Starting Data Register >>	10 to 40	ACK only	Performs an absolute position move using move parameters contained in the indicated **User Data Registers**. This command works like the basic **Move Absolute, Velocity Based (MAV)** command in all other ways.
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		
EXTENDED REGISTER MOVE RELATIVE, TIME BASED (XRT) (Class "D")	178 (0xB2) [9 Words]	<<Starting Data Register >>	10 to 40	ACK only	Performs a relative distance move using move parameters contained in the indicated **User Data Registers**. This command works like the basic **Move Relative, Time Based (MRT)** command in all other ways.
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
EXTENDED REGISTER MOVE RELATIVE, VELOCITY BASED (XRV) (Class "D")	178 (0xB2) [9 Words]	<<Starting Data Register >>	10 to 40	ACK only	Performs a relative distance move using move parameters contained in the indicated **User Data Registers**. This command works like the **Move Relative, Velocity Based (MRV)** command in all other ways.
		< Stop Enable >	0 to 65535 (0 to 0xFFFF)		
		< Stop State >	0 to 65535 (0 to 0xFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

Program Conditional & Flow Commands

(NV = Non-Volatile memory)

CALCULATION (CLC) (Class D)	215 (0xD7) [3 Words]	< Operation >	See Command	ACK only	Performs a math calculation or function using a specified **Data Register. Data Register #10** is used as the first argument in two argument math operations. **Data Register #10** is also used as an accumulator where the results of most calculations are placed. Calculation result affects status in the **Internal Status Word**. The indirect load and use register 10 for the data and the data in the given register for the address.
	165 2 words < operation > = High Byte < Data Reg. > = Low Byte	< Data Register >	0 to 40, 200 to 211		
Clear Program (CLP) (Class B)	8 (0x8)	NONE	NONE	ACK only	Initialize the Command buffer. Clear out any existing program in the command buffer.
DELAY (DLY) (Class D)	140 (0x8C) [3 Words]	<< Tick Count >>	-2,147,483,647 to 2,147,483,647 (0x8000001 to 0x7FFFFFF)	ACK only	If the value is positive causes a program to wait until the value has counted down. If the count value is negative, only counts down.
END PROGRAM (END) (Class D)	128 (0x80) [1 Word]	NONE	NONE	ACK only	Puts the motor into position holding mode. (Note: commands in a program following this command will NOT be executed!)
JUMP ON INPUTS, AND-ed (JAN) (Class "E")	250 (0xFA) [4 Words]	< IOS Condition Enable >	0 to 65535	ACK only	Allows looping and other conditional branching inside a Program based on the **AND-ed** condition of the **I/O State Word (IOS).**
		< IOS Condition State >	0 to 65535		
		<Program Buffer Location>	0 to 199		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
JUMP ON INPUTS, NAND-ed (JNA) (Class "E")	238 (0xEE) [4 Words]	< IOS Condition Enable >	0 to 65535	ACK only	Allows looping and other conditional branching inside a Program based on the **NAND-ed** condition of the **I/O State Word (IOS).**
		< IOS Condition State >	0 to 65535		
		<Program Buffer Location>	0 to 199		
JUMP ON INPUTS, OR-ed (JOR) (Class "E")	239 (0xEF) [4 Words]	< IOS Condition Enable >	0 to 65535	ACK only	Allows looping and other conditional branching inside a Program based on the **OR-ed** condition of the **I/O State Word (IOS).**
		< IOS Condition State >	0 to 65535		
		<Program Buffer Location>	0 to 199		
JUMP (JMP) (Class E)	162 (0xA2) [4 Words]	<Condition Enable>	0 to 32767 (0 to 0x7FFF)	ACK only	Jumps within a Program. If the condition parameters are set to zero an unconditional jump will occur.
		<Condition State>	0 to 32767 (0 to 0x7FFF)		
		< Command Buffer Address >	0 to 199 (0 to 0xC7)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
JUMP ON INPUT (JOI) (Class E)	162 (0xA2) [4 Words]	<I/O Code #>	-1 to -14	ACK only	During Program execution, uses an input to conditionally "Jump" to another program line. Uses the JUMP command with negative numbers.
		<I/O State>	0 = "Low" 1 = "High"		
		<Command Buffer Location>	0 to 199		
JUMP ON REGISTER EQUAL (JRE) (Class E)	137 (0x89) [5 Words]	<Register>	0 to 40, 200 to 211	ACK only	During Program execution, it compares the contents of the given register with the supplied Value and jumps to the selected buffer location if they are equal.
		<<Value>>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)		
		<Command Buffer Location>	0 to 199		
Load Program (LPR) (Class B)	14 (0x0E)	< NV Memory Address >	0 to 3839 (0 to 0x0EFF)	ACK only	Reads a program from non-volatile memory and places it into command buffer. Use **Read RAM** to read data from Command buffer.
		< Count > The Count is typically set to "0"	**0** = use count stored at first address location. **1 to 199** = read the literal word count.		
LOAD & RUN PROGRAM (LRP) (Class D)	156 (0x9C) [2 Words]	<NV Memory Address >	0 to 3839 (0 to 0x0EFF)	ACK only	Loads a stored Program from Non-volatile memory and jumps to it.
PROGRAM CALL (PCL) (Class D)	201 (0xC9) [4 Words]	< Program Buffer Location>	0 to 199		Works the same as the SilverMax "Jump in Program" command except the next program line is stored for a "Return". This works the similar to a "GOSUB" in "Basic" the programming language
		<Condition Enable>	0 to 32767 (0 to 0x7FFF)		
		<Condition State>	0 to 32767 (0 to 0x7FFF)		
PROGRAM CALL ON INPUT (PCI) (Class D)	201 (0xC9) [4 Words]	< Program Buffer Location>	0 to 199		Works the same as the **PROGRAM CALL** using the digital inputs
		<I/O Enable>	-1 to -14		
		<I/O State>	0 or 1		
PROGRAM RETURN (PRT) (Class E)	202 (0xCA) [3 Words]	<Condition Enable>	0 to 32767 (0 to 0xFFFF)		Returns program execution to the place where a "Program Call" command was executed.
		<Condition State>	0 to 32767 (0 to 0xFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
PROGRAM RETURN ON INPUT (PRI) (Class E)	202 (0xCA) [3 Words]	<I/O Enable>	-1 to -14		Works the same as the **PROGRAM RETURN** using the digital inputs
		<I/O State>	0 or 1		
Run Program (RUN) (Class C)	10 (0x0A)	NONE	NONE	ACK only	Runs the loaded program. Only valid if motor is not running and a program is loaded.
Start Download (SDL) (Class B)	9 (0x9)	NONE	NONE	ACK only	Normal use has no data included; it is used to put SilverMax into **download mode**. Note: CAN ONLY BE USED AFTER **Clear Buffer**
Store Program (SPR) (Class C)	13 (0x0D)	< NV Memory Address >	0 to 3839 (0 to 0x0EFF)	ACK only	Writes the loaded program into non-volatile memory. Cannot execute while SilverMax is running.
WAIT ON BIT EDGE (WBE) (Class D)	204 (0xCC) [3 Words]	<Input Code>	1 to 14		Same as "Wait on Bit State" except SilverMax is looking for an "Edge" transition.
		<Input Transition>	0 = falling 1 = rising		
WAIT ON BIT STATE (WBS) (Class D)	194 (0xC2) [3 Words]	<Input Code>	1 to 14		During Program, execution causes SilverMax to "Wait" until an input condition is true. This is a very fast input check.
		<Input State>	0 = "Low" 1 = "High"		
WAIT DELAY (WDL) (Class D)	141 (0x8D) [1 Word]	NONE	NONE	ACK only	Waits until delay has counted down

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

I/O Commands

ANALOG CONTINUOUS READ (ACR) (Class D)	207 (0xCF) [3 Words]	<Analog Channel #>	Same as Analog Read Input command below except "9" not used and 0 = "Disable"		This does continuous read of an Analog channel. Readings are taken every servo cycle (120 usec.). Analog channels are used same as below except "9" is not used with this command
		<Data Register>	10 to 40		
ANALOG READ INPUT (ARI) (Class D)	193 (0xC1) [3 Words]	<Analog Channel #>	1 = Analog #1 2 = Analog #2 3 = Analog #3 4 = Analog #4 5 = Analog #1 and Analog #2 6 = Analog #3 and Analog #4 7 = V+ (non-calibrated) 8 = Temperature (ADC counts) 9 = V+ scale factor		This does a single read of an Analog channel. Analog channels 1, 2, 3 or 4 are the standard inputs. Using a "5" for the channel uses 1 & 2 in differential mode a "6" uses 3 & 4 in differential mode. "7" reads back the V+ input voltage non-calibrated. "9" reads the input voltage scale factor into a Data Register. "8" reads back the Temperature value non-calibrated
		<Data Register>	10 to 40		
CONFIGURE I/O (CIO) (Class D) (Default is all I/O set for input)	188 (0xBC) [3 Words]	<I/O Line #>	1 to 7		Configures the Selected I/O bit for "Input" or "Output". If setting for "Output" the logic level can also be set.
		<Setting>	-1 = Input 0 = Clear (Low) 1 = Set (High)		
CLEAR OUTPUT BIT (COB) (Class D)	206 (0xCE) [2 Words]	<I/O Line #>	1 to 7		Clears the selected I/O bit to a "Low" logic "0" condition (Output = 0 volts)
DISABLE ENCODER MONITOR (DEM) (Class D) (This is Default)	171 (0xAB) [1 Word]	NONE	NONE	ACK only	Changes digital inputs 1,2,3 back to inputs.
ENABLE ENCODER MONITOR (EEM) (Class D)	170 (0xAA) [1 Word]	NONE	NONE	ACK only	Changes digital inputs 1,2,3 to Encoder Outputs A,B,I
MODULO CLEAR (MDC) (Class D)	190 (0xBE) [1 Words]	NONE	NONE	ACK only	Clears Modulo usage of I/O #6 & #7

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
MODULO SET (MDS) (Class D)	189 (0xBD) [4 Words]	<Count>	1 to 256 (External)	ACK only	Sets up a Modulo output of the internal encoder on I/O #6 & #7. (See I/O Configuration Chart). "External" is a hardware counter that is very accurate but limited to 256.
		<Encoder Source>	0 = Internal 1 = External		
		<Output Format>	0 = A/B Quad 1 = Pulse Up/Dn 2 = Pulse & Dir		
MODULO TRIGGER (MDT) (Class D)	191 (0xBF) [2 Words]	<Trigger Mode>	**0** = Disable until I/O #1 is High **1** = Enable **2** = Gate modulo using I/O #1	ACK only	Enables the Modulo output to be triggered by an external input on I/O #1. Trigger can be used, as a "One-Shot" if desired.
POSITION COMPARE (PCP) (Class "D")	245 (0xBF) [2 Words]	<Starting User Data Register>	**0** = Disable Usage 10 to 40	ACK only	Causes **I/O #1** to toggle its state when the motor position is equal to or greater than (absolute value) the "Position" value contained in the first of two **User Data Registers**.
SET OUTPUT BIT (SOB) (Class D)	205 (0xCD) [2 Words]	<I/O Line #>	1 to 7	ACK only	Sets the selected I/O line to a "High" logic "1" condition (Output = +5 volts)

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

Data Register Commands

(NV = Non-Volatile memory)

ADD TO REGISTER (ATR) (Class "D")	248 (0x9A) [4 Words]	< Data Register >	10 to 40	ACK only	Adds the included data into the selected 32 bit **Data Register.**
		<< Data to Add >>	-2,147,483,648 to +2,147,483,647 (0 to 0xFFFFFFFF)		
REGISTER LOAD MULTIPLE (RLM) (Class D)	197 (0xC5) [4 Words]	<Number of Registers>	1 to 4	ACK only	Loads data to an array of **Data Registers** from the selected **Non-Volatile Memory** address. The Checksum value is checked to insure good data.
		<Starting Data Register>	10 to 40		
		<NV Memory Address>	0 to 3839 (0 to 0x0EFF)		
REGISTER LOAD NON-VOLATILE (RLN) (Class D)	199 (0xC7) [3 Words]	<Data Register>	10 to 40	ACK only	Loads data to the selected **Data Register** from the selected **Non-Volatile Memory** address. The Checksum value is checked to insure good data
		<NV Memory Address>	0 to 3839 (0 to 0x0EFF)		
REGISTER STORE MULTIPLE (RSM) (Class D)	196 (0xC4) [4 Words]	<Number of Registers>	1 to 4	ACK only	Stores an array of Data Registers to the selected Non-Volatile Memory address. A Checksum is also stored for the array of data.
		<Starting Data Register>	10 to 40		
		<NV Memory Address>	0 to 3839 (0 to 0x0EFF)		
REGISTER STORE NON-VOLATILE (RSN) (Class D)	198 (0xC6) [3 Words]	<Data Register>	10 to 40	ACK only	Stores the indicated Data Register Value to the selected Non-Volatile Memory address. A Checksum of the value is also stored
		<NV Memory Address>	0 to 3839 (0 to 0x0EFF)		
Read Register (RRG) (Class A)	12 (0x0C)	<Data Register>	0 to 40	Data of 4 Bytes	Reads the given **Data Register**. (See **Data Registers**)

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description
WRITE CMD LONG WORD (WCL)	138 (0X8A)	<Register>	0 to 40, 200 to 211 (0 to 0x28, 0xC8 to 0xD3)	ACK only	Moves the Long Word in the register as pointed to by "Register" into the given location in the CMD buffer. Great precautions need to be exercised as both commands and parameters may be modified. This allows any 32 bit command parameter to be set from a register.
		<CMD Buffer Location>	0 to 199 (0x0 to 0xC7)		
WRITE CMD WORD (WCW)	139 (0X8B)	<Register>	0 to 40, 200 to 211 (0 to 0x28, 0xC8 to 0xD3)	ACK only	Moves the Word in the low half of the register as pointed to by "Register" into the given location in the CMD buffer. Great precautions need to be exercised as both commands and parameters may be modified. This allows any 16 bit command parameter to be set from a register.
		<CMD Buffer Location>	0 to 199 (0x0 to 0xC7)		
Write Register, Immediate Type (WRI) (Class A) NOTE: Can effect program execution	11 (0x0B)	<Data Register >	10 to 40 (0x0A to 0x28)	ACK only	Writes the supplied data to the indicated **Data Register**
		<<Data >>	0 to 4,294,967,295 (0 to 0xFFFFFFFF) or -2,147,483,648 to +2,147,483,647		
WRITE REGISTER, PROGRAM TYPE (WRP) (Class D)	154 (0x9A) [4 Words]	< Data Register >	10 to 40	ACK only	Stores data in a User Data Register. Data Registers below 10 are not available for writing.
		<< Data >>	0 to 4,294,967,295 (0 to 0xFFFFFFFF)		

Command Name	Command Code (Hex)	Command Parameters	Parameter Range (Hex)	SilverMax Response	Description

Misc. Commands

CLEAR MAX ERROR (CME) (Class D)	147 (0x93) [1 Word]	NONE	NONE	ACK only	Zero out the **Maximum Error Data Register** value.
CLEAR INTERNAL STATUS (CIS) (Class D)	163 (0xA3) [1 Word]	NONE	NONE	ACK only	Clear the **Internal Status Word** of any condition bits that are set
CHECK INTERNAL STATUS (CKS) (Class D)	164 (0xA4) [3 Words]	<Condition Enable> < Condition State >	0 to 65535 (0 to 0xFFFF) 0 to 65535 (0 to 0xFFFF)	ACK only	Check the **Internal Status Word** bits. If conditions are met, set bit #6 of the **Polling Status Word**. "0" in parameters always sets bit #6
SET TARGET TO POSITION (TTP) (Class D)	146 (0x92) [1 Word]	NONE	NONE	ACK only	Target register to current motor position.
ZERO TARGET (ZTG) (Class D)	144 (0x90) [1 Word]	NONE	NONE	ACK only	Zeros the target location, offset the position the amount require to zero target.
ZERO TARGET & POSITION (ZTP) (Class D)	145 (0x91) [1 Word]	NONE	NONE	ACK only	Zero out both the target and the position register.

SILVERMAX COMMAND SET - NUMERIC/TLA LIST

≅ **Some commands share the same command number. This occurs when a SilverMax command accepts alternate parameters or has multiple uses.**

Command Number	Three Letter Acronym (TLA)	Command Name	Reference: Page #
		Immediate Type Commands	
0	POL	POLL	19
1	CPL	CLEAR POLL	17
2	HLT	HALT	25
3	STP	STOP	29
4	RST	RESTART	26
5	RVN	REVISION	23
6	RPB	READ PROGRAM BUFFER	22
8	CLP	CLEAR PROGRAM	124
9	SDL	START DOWNLOAD	142
10	RUN	RUN PROGRAM	141
11	WRI	WRITE REGISTER, IMMEDIATE TYPE	172
12	RRG	READ REGISTER	168
13	SPR	STORE PROGRAM	143
14	LPR	LOAD PROGRAM	135
15	VMI	VELOCITY MODE, IMMEDIATE TYPE	87
17	SSP	SINGLE STEP PROGRAM	28
18	SSE	SINGLE STEP EXIT	27
20	RIS	READ INTERNAL STATUS WORD	21
21	RIO	READ I/O STATES	20
25	IMW	INTERPOLATED MODE WRITE QUEUE	95
		Program Type Commands	
128	END	END PROGRAM	126
134	MAV	MOVE ABSOLUTE, VELOCITY BASED	99
135	MRV	MOVE RELATIVE, VELOCITY BASED	103
137	JRE	JUMP ON REGISTER EQUAL	134
138	WCL	WRITE COMMAND LONG WORD	174
139	WCW	WRITE COMMAND WORD	175
140	DLY	DELAY	125
141	WDL	WAIT DELAY	146
142	GCL	GO CLOSED LOOP	77
143	GOP	GO OPEN LOOP	78
144	ZTG	ZERO TARGET	181
145	ZTP	ZERO TARGET AND POSITION	182
146	TTP	SET TARGET TO POSITION	180
147	CME	CLEAR MAX ERROR	177
148	CTC	CONTROL CONSTANTS	37

Command Number	Three Letter Acronym (TLA)	Command Name	Reference: Page #
		Program Type Commands	
149	TQL	TORQUE LIMITS	73
150	AHC	ANTI-HUNT CONSTANTS	32
151	ERL	ERROR LIMITS	50
152	OLP	OPEN LOOP PHASE	63
154	WRP	WRITE REGISTER, PROGRAM TYPE	173
155	IDT	IDENTITY	54
156	LRP	LOAD AND RUN PROGRAM	136
159	VMP	VELOCITY MODE, PROGRAM TYPE	88
160	RAV	REGISTER MOVE ABSOLUTE, VELOCITY BASED	113
161	RRV	REGISTER MOVE RELATIVE, VELOCITY BASED	115
≅162	JMP	JUMP	130
≅162	JOI	JUMP ON INPUT	132
163	CIS	CLEAR INTERNAL STATUS	178
164	CKS	CHECK INTERNAL STATUS	179
165	CLC	CALCULATION	121
167	KMC	KILL MOTOR CONDITIONS	57
168	MCT	MOTOR CONSTANTS	61
169	FLC	FILTER CONSTANTS	52
170	EEM	ENABLE ENCODER MONITOR	155
171	DDB	DISABLE DONE BIT	38
≅171	DEM	DISABLE ENCODER MONITOR	154
172	PAC	PHASE ADVANCE CONSTANTS	65
173	ADL	ACK DELAY	31
174	BRT	BAUD RATE	35
176	MAT	MOVE ABSOLUTE, TIME BASED	97
177	MRT	MOVE RELATIVE, TIME BASED	101
178	RAT	REGISTER MOVE ABSOLUTE, TIME BASED	112
179	RRT	REGISTER MOVE RELATIVE, TIME BASED	114
180	SSD	SCALED STEP AND DIRECTION	81
181	KMR	KILL MOTOR RECOVERY	59
182	KED	KILL ENABLE DRIVER	56
183	KDD	KILL DISABLE DRIVER	55
184	DIR	DIRECTION	40
185	PRO	PROTOCOL	67
186	SIF	SERIAL INTERFACE	70
187	EDL	ENABLE DONE LOW	46
188	CIO	CONFIGURE I/O	152
189	MDS	MODULO SET	157
190	MDC	MODULO CLEAR	156
191	MDT	MODULO TRIGGER	158
192	SEE	SELECT EXTERNAL ENCODER	69
193	ARI	ANALOG READ INPUT	150

Command Number	Three Letter Acronym (TLA)	Command Name	Reference: Page #
		Program Type Commands	
194	WBS	WAIT ON BIT STATE	145
195	SCF	S-CURVE FACTOR	68
196	RSM	REGISTER STORE MULTIPLE	169
197	RLM	REGISTER LOAD MULTIPLE	165
198	RSN	REGISTER STORE TO NON-VOLATILE	171
199	RLN	REGISTER LOAD FROM NON-VOLATILE	167
201	PCL	PROGRAM CALL	137
≅201	PCI	PROGRAM CALL ON INPUT	138
202	PRT	PROGRAM RETURN	139
≅202	PRI	PROGRAM RETURN ON INPUT	140
204	WBE	WAIT ON BIT EDGE	144
205	SOB	SET OUTPUT BIT	160
206	COB	CLEAR OUTPUT BIT	153
207	ACR	ANALOG CONTINUOUS READ	148
208	PLR	POWER LOW RECOVERY	66
211	CAI	CALIBRATE ANALOG INPUT FROM NON-VOLATILE	36
212	LVT	LOW VOLTAGE TRIP	60
213	OVT	OVER VOLTAGE TRIP	64
214	MTT	MAXIMUM TEMPERATURE TRIP	62
215	CLC	CALCULATION	121
216	PIM	POSITION INPUT MODE	79
217	VIM	VELOCITY INPUT MODE	84
218	TIM	TORQUE INPUT MODE	83
219	AHM	ANTI-HUNT MODE	34
221	SSL	SOFT STOP LIMITS	72
222	TRU	TORQUE RAMP UP	75
223	RSD	REGISTERED STEP & DIRECTION	80
225	EMT	ENABLE MULTI-TASKING	48
226	DMT	DISABLE MULTI-TASKING	44
227	EMD	ENABLE MOTOR DRIVER	47
228	DMD	DISABLE MOTOR DRIVER	43
229	HSM	HARD STOP MOVE	91
230	AHD	ANTI-HUNT DELAY	33
231	PCM	PRE-CALCULATE MOVE	106
232	PCG	PRE-CALCULATED GO	105
233	XRV	EXTENDED REGISTER MOVE RELATIVE, VELOCITY BASED	119
234	XAV	EXTENDED REGISTER MOVE ABSOLUTE, VELOCITY BASED	117
235	XRT	EXTENDED REGISTER MOVE RELATIVE, TIME BASED	118

Command Number	Three Letter Acronym (TLA)	Command Name	Reference: Page #
		Program Type Commands	
236	XAT	EXTENDED REGISTER MOVE ABSOLUTE, TIME BASED	116
237	GOC	GRAVITY OFFSET CONSTANT	53
238	JNA	JUMP ON INPUTS, NAND-ed	128
239	JOR	JUMP ON INPUTS, OR-ed	129
240	PMC	PROFILE MOVE CONTINUOUS	107
241	PMV	PROFILE MOVE	110
242	PMX	PROFILE MOVE EXIT	111
243	DLC	DUAL LOOP CONTROL	41
244	SLC	SINGLE LOOP CONTROL	71
245	PCP	POSITION COMPARE	159
248	ATR	ADD TO REGISTER	164
249	PMO	PROFILE MOVE OVERRIDE	109
250	JAN	JUMP ON INPUTS, ANDED	127
251	EDH	ENABLE DONE HIGH	45
252	DIF	DIGITAL INPUT FILTER	39
253	IMS	INTERPOLATED MODE START	92
254	IMQ	INTERPOLATED MODE QUEUE CLEAR	94

SILVERMAX COMMAND NAME CROSS REFERENCE TABLE

The SilverMax command set has been revised through extensive "re-naming" and the addition of a designated three letter acronym (TLA) for each command name. The following cross reference table associates the previous command names (QuickControl software version 2.8 & earlier) to the revised names (QuickControl software version 3.0 & later). The table also lists the "NEW" commands recognized by "E" series motors **ONLY**.

The commands listed in ALL CAPS are "Program Commands", formerly designated as "Block Commands". They retain all previous attributes for storage in the SilverMax non-volatile memory.

Three Letter Acronym	Command Numbers	Command Names (By category)	Previous Command Names (prior to "E" series)	Execution Type	SilverMax Model
Status Commands					
CPL	1	Clear Poll	Clear Poll	Immediate	
POL	0	Poll	Poll	Immediate	
RIO	21	Read I/O States	----------	Immediate	E-Series
RIS	20	Read Internal Status Word	----------	Immediate	E-Series
RPB	6	Read Program Buffer	Read RAM	Immediate	
RVN	5	Revision	Revision	Immediate	
WPB	7	Write Program Buffer (RAM)	Write RAM	Immediate	
Override Commands					
HLT	2	Halt	Halt	Immediate	
RST	4	Restart	Restart	Immediate	
SSE	18	Single Step Exit	----------	Immediate	E-Series
SSP	17	Single Step Program	----------	Immediate	E-Series
STI	3	Stop (Immediate Mode)	Stop	Immediate	
Initialization Commands					
ADL	173	ACK DELAY	Ack Delay	Program	
AHC	150	ANTI-HUNT CONSTANTS	Anti-Hunt Constants	Program	
AHM	219	ANTI-HUNT MODE		Program	E-Series Rev 329, 427
AHD	230	ANTI-HUNT DELAY	----------	Program	E-Series Rev 321
BRT	174	BAUD RATE	Set Baud Rate	Program	
CTC	148	CONTROL CONSTANTS	Control Constants	Program	
DDB	171	DISABLE DONE BIT	----------	Program	E-Series
DIF	252	DIGITAL INPUT FILTER	----------	Program	E-Series Rev 322

DIR	184	DIRECTION	----------	Program	E-Series
DLC	243	DUAL LOOP CONTROL	----------	Program	E-Series Rev 321
DMD	228	DISABLE MOTOR DRIVER	----------	Program	E-Series Rev 321
DMT	226	DISABLE MULTI-TASKING	----------	Program	E-Series Rev 321
EDH	251	ENABLE DONE HIGH	----------	Program	E-Series Rev 322
EDL	187	ENABLE DONE LOW	----------	Program	E-Series Rev 322
EMD	227	ENABLE MOTOR DRIVER	----------	Program	E-Series Rev 321
EMT	225	ENABLE MULTI-TASKING	----------	Program	E-Series Rev 321
ERL	151	ERROR LIMITS	----------	Program	
FLC	169	FILTER CONSTANTS	Velocity Constants	Program	
GOC	237	GRAVITY OFFSET CONSTANT	----------	Program	E-Series Rev 321
IDT	155	IDENTITY	Set Identity	Program	
KDD	183	KILL DISABLE DRIVERS	----------	Program	E-Series Rev 321
KED	182	KILL ENABLE DRIVERS	----------	Program	E-Series Rev 321
KMC	167	KILL MOTOR CONDITIONS	Kill Motor Mask	Program	
KMR	181	KILL MOTOR RECOVERY	Kill Motor Recovery	Program	
LVT	212	LOW VOLTAGE TRIP	----------	Program	E-Series
MCT	168	MOTOR CONSTANTS	Motor constants	Program	
MTT	214	MAXIMUM TEMPERATURE TRIP	----------	Program	E-Series
OLP	152	OPEN LOOP PHASE	Set Open Loop Phase	Program	
OVT	213	OVER VOLTAGE TRIP	----------	Program	E-Series
PAC	172	PHASE ADVANCE CONSTANTS	Phase Advance constants	Program	
PLR	208	POWER LOW RECOVERY	----------	Program	E-Series
PRO	185	PROTOCOL	----------	Program	E-Series
SCF	195	S-CURVE FACTOR	----------	Program	E-Series
SEE	192	SELECT EXTERNAL ENCODER	----------	Program	E-Series
SIF	186	SERIAL INTERFACE	----------	Program	E-Series
SLC	244	SINGLE LOOP CONTROL	----------	Program	E-Series Rev 321
SSL	221	SOFT STOP LIMITS	----------	Program	E-Series
TQL	149	TORQUE LIMITS	Motor Torque	Program	
TRU	222	TORQUE RAMP UP	----------	Program	E-Series

Mode Commands					
GCL	142	GO CLOSED LOOP	Go Closed Loop	Program	
GOP	143	GO OPEN LOOP	Go Open Loop	Program	
PIM	216	POSITION INPUT MODE(ACTUALLY TARGET INPUT)	----------	Program	E-Series
RSD	223	REGISTERED STEP & DIRECTION	----------	Program	E-Series Rev 321
SSD	180	SCALED STEP AND DIRECTION	Scaled Step & Direction	Program	(2nd Filter added Rev 428, 329
TIM	218	TORQUE INPUT MODE	----------	Program	E-Series
VIM	217	VELOCITY INPUT MODE	----------	Program	E-Series
VMI	15	VELOCITY MODE, IMMEDIATE MODE	Change Velocity	Immediate	
VMP	159	VELOCITY MODE, PROGRAM MODE	Slew Acceleration Velocity	Program	
Motion & Profile Move Commands					
HSM	229	HARD STOP MOVE	----------	Program	E-Series Rev 321
IMQ	253	INTERPOLATED MOVE QUEUE CLEAR		Program	E-Series Rev 424, 329
IMS	254	INTERPOLATED MOVE START		Program	E-Series Rev 424, 329
IMW	25	INTERPOLATED MOVE WRITE TO QUEUE		Immediate	E-Series Rev 424, 329
MAT	176	MOVE ABSOLUTE, TIME BASED	Location Acceleration Time Total Time	Program	
MAV	134	MOVE ABSOLUTE, VELOCITY BASED	Location Acceleration Velocity	Program	
MRT	177	MOVE RELATIVE, TIME BASED	Distance Acceleration Time Total Time	Program	
MRV	135	MOVE RELATIVE, VELOCITY BASED	Distance Acceleration Velocity	Program	
PCG	232	PRE-CALCULATED GO	----------	Program	E-Series Rev 321
PCM	231	PRE-CALCULATE MOVE	----------	Program	E-Series Rev 321
PMC	240	PROFILE MOVE CONTINUOUS	----------	Program	E-Series Rev 321
PMO	249	PROFILE MOVE OVERRIDE	----------	Program	E-Series Rev 321
PMV	241	PROFILE MOVE	----------	Program	E-Series Rev 321
PMX	242	PROFILE MOVE EXIT	----------	Program	E-Series Rev 321

RAT	178	REGISTER MOVE ABSOLUTE, TIME BASED	Symbolic Location Acceleration Time Total Time	Program	
RAV	160	REGISTER MOVE ABSOLUTE, VELOCITY BASED	Symbolic Location Acceleration Velocity	Program	
RRT	179	REGISTER MOVE RELATIVE, TIME BASED	Symbolic Distance Acceleration Time Total Time	Program	
RRV	161	REGISTER MOVE RELATIVE, VELOCITY BASED	Symbolic Distance Acceleration Velocity	Program	
XAT	236	EXTENDED REGISTER MOVE ABSOLUTE, TIME BASED	----------	Program	E-Series Rev 321
XAV	234	EXTENDED REGISTER MOVE ABSOLUTE, VELOCITY BASED	----------	Program	E-Series Rev 321
XRT	235	EXTENDED REGISTER MOVE RELATIVE, TIME BASED	----------	Program	E-Series Rev 321
XRV	233	EXTENDED REGISTER MOVE RELATIVE, VELOCITY BASED	----------	Program	E-Series Rev 321
Program Flow Commands					
CLC	215	CALCULATION	Calculate Destination	Program	
CLP	8	CLEAR PROGRAM	Clear Buffer	Immediate	
DLY	140	DELAY	Set Delay	Program	
END	128	END PROGRAM	Go Anti-Hunt	Program	
JAN	250	JUMP ON INPUTS, ANDED	----------	Program	E-Series Rev 322
JNA	238	JUMP ON INPUTS, NANDED	----------	Program	E-Series Rev 321
JMP	162	JUMP	Jump In Block	Program	
JOI	162	JUMP ON INPUT	----------	Program	E-Series
JOR	239	JUMP ON INPUTS, ORED	----------	Program	E-Series Rev 321
JRE	137	JUMP ON REG EQUAL		Program	E-Series Rev 329,426
LPR	14	LOAD PROGRAM	Load Block	Immediate	
LRP	156	LOAD AND RUN PROGRAM	Load and Run Block	Program	
PCI	201	PROGRAM CALL ON INPUT	----------	Program	E-Series
PCL	201	PROGRAM CALL	----------	Program	E-Series

PRI	202	PROGRAM RETURN ON INPUT	----------	Program	E-Series
PRT	202	PROGRAM RETURN	----------	Program	E-Series
RUN	10	RUN PROGRAM	Run Block	Immediate	
SDL	9	START DOWNLOAD	Send To Buffer	Immediate	
SPR	13	STORE PROGRAM	Store Block	Immediate	
WBE	204	WAIT ON BIT EDGE	----------	Program	E-Series
WBS	194	WAIT ON BIT STATE	----------	Program	E-Series
WDL	141	WAIT DELAY	Wait Delay	Program	
I/O Commands					
ACR	207	ANALOG CONTINUOUS READ	----------	Program	E-Series
ARI	193	ANALOG READ INPUT	----------	Program	E-Series
CIO	188	CONFIGURE I/O (DEFAULT IS ALL I/O SET FOR INPUT)	----------	Program	E-Series
COB	206	CLEAR OUTPUT BIT	----------	Program	E-Series
DEM	171	DISABLE ENCODER MONITOR	Hide Encoder	Program	
EEM	170	ENABLE ENCODER MONITOR	View Encoder	Program	
MDC	190	MODULO CLEAR	----------	Program	E-Series
MDS	189	MODULO SET	----------	Program	E-Series
MDT	191	MODULO TRIGGER	----------	Program	E-Series
PCP	245	POSITION COMPARE	----------	Program	E-Series Rev 321
SOB	205	SET OUTPUT BIT	----------	Program	E-Series
Data Register Commands					
ATR	248	ADD TO REGISTER	----------	Program	E-Series Rev 321
RLM	197	REGISTER LOAD MULTIPLE	----------	Program	E-Series
RLN	199	REGISTER LOAD FROM NON-VOLATILE	----------	Program	E-Series
RRG	12	READ REGISTER	Read Symbolic	Immediate	
RSM	196	REGISTER STORE MULTIPLE	----------	Program	E-Series
RSN	198	REGISTER STORE TO NON-VOLATILE	----------	Program	E-Series
WRI	11	WRITE REGISTER, IMMEDIATE MODE	Write Symbolic	Immediate	
WRP	154	WRITE REGISTER, PROGRAM MODE	Store Symbolic	Program	
Miscellaneous Function Commands					

CIS	163	CLEAR INTERNAL STATUS	Clear Target Status	Program	
CKS	164	CHECK INTERNAL STATUS	Check Target Status	Program	
CME	147	CLEAR MAX ERROR	Clear Max Error	Program	
TTP	146	SET TARGET TO POSITION	Set Target to Position	Program	
WCL	138	WRITE COMMAND BUFFER LONG WORD		Program	E-Series Rev 427, 329
WCW	139	WRITE COMMAND BUFFER WORD		Program	E-Series Rev 427, 329
ZTG	144	ZERO TARGET	Zero Target	Program	
ZTP	145	ZERO TARGET AND POSITION	Zero Target and Position	Program	

INDEX

8

8-Bit ASCII, 67

9

9-Bit Binary, 67

A

A & B Quadrature, 81
A/B Quad, 69
Absolute position, 97, 99
Absolute Value, 122
Acceleration, 100, 104, 113
Acceleration Feedback, 37, 52
Acceleration Feedforward, 37
Acceleration Parameters, 11
Acceleration Time, 98, 102, 112, 114
ACK, 31
ACK DELAY (ADL), 31
Acknowledgement (ACK), 31
Add, 122
ADD TO REGISTER (ATR), 164
ANALOG CONTINUOUS READ (ACR), 148, 149
ANALOG READ INPUT (ARI), 150, 151
AND, 122
ANTI-HUNT CONSTANTS (AHC), 32
ANTI-HUNT DELAY (AHD), 33
Anti-hunt mode, 32
ANTI-HUNT MODE (AHM), 34

B

BAUD RATE (BRT), 35
Bits per second, 35

C

CALCULATION (CLC), 121
CALIBRATE ANALOG INPUT FROM NV (CAI), 36
Call, 137, 138, 139
CHECK INTERNAL STATUS (CKS), 179
Class “A” Commands, 14
Class “B” Commands, 14
Class “C” Commands, 14
Class “D” Commands, 14

C

Class “E” Commands, 14
Class “F” Commands, 14
Clear, 122
CLEAR INTERNAL STATUS (CIS), 178
CLEAR MAX ERROR (CME), 177
CLEAR OUTPUT BIT (COB), 153
Clear Poll (CPL), 17
Clear Program (CLP), 124
Clockwise, 40
Closed Loop, 77
Closed Loop Holding, 73
Closed Loop Moving, 73
“clutch”, 50
Command Classifications, 14
Command Numbers, 10
Command Parameters, 10
Command Structure, 10
Command Types, 13
CONFIGURE I/O (CIO), 152
CONTROL CONSTANTS (CTC), 37
Copy, 122
counter, 125
counter clockwise, 40

D

Data Register Commands, 161, 162, 209
Day, 23
Decrement, 122
Delay, 146
DELAY (DLY), 125
DIGITAL INPUT FILTER (DIF), 39
DIRECTION (DIR), 40
DISABLE DONE BIT (DDB), 38
DISABLE DRIVER, 55
DISABLE ENCODER MONITOR (DEM), 154
DISABLE MOTOR DRIVER (DMD), 43
DISABLE MULTI-TASKING (DMT), 44
DIV, 122
“Done”, 45, 46
download, 142
“Drag”, 50
DUAL LOOP CONTROL (DLC), 41

E

ENABLE DONE HIGH (EDH), 45
ENABLE DONE LOW (EDL), 46
ENABLE DRIVER, 56
ENABLE ENCODER MONITOR (EEM), 155
ENABLE MOTOR DRIVER (EMD), 47
ENABLE MULTI-TASKING (EMT), 48
Encode Monitor, 154
encoder, 69
Encoder Monitor, 155
END PROGRAM (END), 126
Error, 177
ERROR LIMITS (ERL), 50
Examples, 15
EXTENDED REGISTER MOVE ABSOLUTE, TIME BASED (XAT), 116
EXTENDED REGISTER MOVE ABSOLUTE, VELOCITY BASED (XAV), 117
EXTENDED REGISTER MOVE RELATIVE, TIME BASED (XRT), 118
EXTENDED REGISTER MOVE RELATIVE, VELOCITY BASED (XRV), 119
external encoder, 69
External Encoder, 41

F

filter, 39
FILTER CONSTANTS (FLC), 52
Filter Parameters, 11

G

Global Identifier, 54
GO CLOSED LOOP (GCL), 77
GO OPEN LOOP (GOL), 78
GRAVITY OFFSET CONSTANTS (GOC), 53
Group ID, 54
Group Identifier, 54

H

Halt (HLT), 25
HARD STOP MOVE (HSM), 91
Hard stop, 25
Hold, 29
Hold Mode, 50

I

I/O Commands, 147, 207
IDENTITY (IDT), 54

I

Immediate Type Commands.
Increment, 122
INDIRECT ADDRESSING, 165, 167, 169
Initialization Commands, 30, 185
Input, 152
input filter, 39
INPUT MODE USAGE (IMU), 85
Integrator, 37
Internal Status Word, 57, 178, 179
INTERPOLATED MOVE QUEUE CLEAR (IMQ), 94
INTERPOLATED MOVE START (IMS), 92
INTERPOLATED MOVE WRITE QUEUE (IMW), 95

J

JUMP (JMP), 130
JUMP ON INPUT (JOI), 132
JUMP ON INPUTS, AND-ed (JAN), 127
JUMP ON INPUTS, NAND-ed (JNA), 128
JUMP ON INPUTS, OR-ed (JOR), 129
JUMP ON REGISTER EQUAL (JRE), 134

K

Kill Motor Condition, 55, 56
Kill Motor Conditions, 59
KILL MOTOR CONDITIONS (KMC), 57, 58
Kill Motor Recovery, 57
KILL MOTOR RECOVERY (KMR), 59

L

LOAD AND RUN PROGRAM (LRP), 136
Load High Word, 122
LOAD INDIRECT, 122
Load Low Word, 122
Load Program (LPR), 135
logic, 121
Low Voltage Trip, 66
LOW VOLTAGE TRIP (LVT), 60

M

math, 121
MAXIMUM TEMPERATURE TRIP (MTT), 62
Misc. Commands, 176, 211
Mode Commands, 76, 194
MODULO CLEAR (MDC), 156
MODULO SET (MDS), 157
MODULO TRIGGER (MDT), 158
Month, 23

M

Motion & Profile Move Commands, 196
Motion & Profile Move Commands, 89
MOTION & PROFILE MOVE COMMANDS, 90
MOTOR CONSTANTS (MCT), 61
Move Absolute, 112, 113, 116, 117
MOVE ABSOLUTE, TIME BASED (MAT), 98
MOVE ABSOLUTE, VELOCITY BASED (MAV), 99, 100
Move Relative, 114, 115, 118, 119
MOVE RELATIVE, TIME BASED (MRT), 101
MOVE RELATIVE, VELOCITY BASED (MRV), 103, 104
MULT, 122
Multi-Tasking, 44

N

Native SilverMax units, 11
Non-volatile Memory, 169
Non-Volatile Memory, 165, 167, 171

O

open loop, 78
OPEN LOOP PHASE (OLP), 63
Options Number, 23
OR, 122
Output, 152, 160
OUTPUT, 153
Over Temperature, 62
OVER VOLTAGE TRIP (OVT), 64
Override Commands, 24, 184

P

PACK, 122
PHASE ADVANCE CONSTANTS (PAC), 65
Poll (POL), 19
POSITION COMPARE (PCP), 159
Position Error, 177
POSITION INPUT MODE (PIM), 79
Position Parameters, 11
Power Low Recovery, 60
POWER LOW RECOVERY (PLR), 66
PRE-CALCULATE MOVE (PCM), 106
PRE-CALCULATED GO (PCG), 105
PROFILE MOVE (PMV), 110
PROFILE MOVE CONTINUOUS (PMC), 107
PROFILE MOVE EXIT (PMX), 111
PROFILE MOVE OVERRIDE (PMO), 109

P

Program, 136
Program Buffer, 13
Program Buffer Size, 23
PROGRAM CALL (PCL), 137
PROGRAM CALL ON INPUT (PCI), 138
Program Conditional & Flow Commands, 203
Program Flow Commands, 120
PROGRAM RETURN (PRT), 139
PROGRAM RETURN ON INPUT (PRI), 140
Program Type Commands, 13
Proportional, 37
PROTOCOL (PRO), 67

R

Read I/O States (RIO), 20
Read Internal Status Word (RIS), 21
Read Program Buffer (RPB), 22
Read Register (RRG), 168
recovery, 59
Register, 172, 173
REGISTER LOAD MULTIPLE (RLM), 165
REGISTER LOAD NON-VOLATILE (RLN), 167
REGISTER MOVE ABSOLUTE, TIME BASED (RAT), 112
REGISTER MOVE ABSOLUTE, VELOCITY BASED (RAV), 113
REGISTER MOVE RELATIVE, TIME BASED (RRT), 114
REGISTER MOVE RELATIVE, VELOCITY BASED (RRV), 115
REGISTER STORE MULTIPLE (RSM), 169
REGISTER STORE NON-VOLATILE (RSN), 171
REGISTERED STEP & DIRECTION (RSD), 80
Relative Distances, 101, 103
Restart (RST), 26
Return, 137, 139, 140
Revision (RVN), 23
Reset, 26
RS-232, 70
RS-485, 70
Run Program (RUN), 141

S

Save, 122
SAVE HIGH, 122
SAVE INDIRECT, 122
SAVE LOW, 122
SCALED STEP & DIRECTION (SSD), 81

S

Scaled Step and Direction, 80
Scaling, 11
S-CURVE FACTOR (SCF), 68
SELECT EXTERNAL ENCODER (SEE), 69
Serial Communications Buffer Size, 23
SERIAL INTERFACE (SIF), 70
servo, 37
Set & Direction, 80
SET OUTPUT BIT (SOB), 160
SHIFT LEFT, 122
SHIFT RIGHT, 122
SHIFT RIGHT SIGN EXTENDED, 122
SilverMax Command Name Cross Reference Table, 216
SilverMax Command Set - Numeric/TLA List, 212
SilverMax Command Set Overview, 6
SilverMax Commands – Detailed Description, 16
SilverMax Response, 10
SINGLE LOOP CONTROL (SLC), 71
Single Step Exit (SSE), 27
Single Step Program (SSP), 28
SOFT STOP LIMITS (SSL), 72
Shuts down, 25
Status, 21
Stops, 25
Start Download (SDL), 142
Status Commands, 16, 183
Status Word, 57
Step & Dir, 69
Step & Direction, 81
Step and Direction, 81
Step Up & Step Down, 81
Step Up/Dn, 69
Stop, 29
Stop (STP), 29
Store Program (SPR), 143
Subtract, 122
Subtract Target Position, 122
Summary of SilverMax Commands, 183

T

TARGET TO POSITION (TTP), 180
temperature, 62
TIME BASED, 97
Time Parameters, 12
TORQUE INPUT MODE (TIM), 83
TORQUE LIMITS (TQL), 73
TORQUE RAMP UP (TRU), 75
Total Time, 98, 102, 112, 114
tuning, 37

U

UMULT, 122
Unit ID, 54

V

Velocity, 100, 104, 113, 115
Velocity #1 Feedback, 37
Velocity #2 Feedback, 37
Velocity 1 Feedback, 52
Velocity 2 Feedback, 52
Velocity Feedfoward, 37
VELOCITY INPUT MODE (VIM), 84
Velocity Mode, Immediate Type (VMI), 87
VELOCITY MODE, PROGRAM TYPE (VMP), 88
Velocity Parameters, 11
voltage, 64

W

WAIT DELAY (WDL), 146
WAIT ON BIT EDGE (WBE), 144
WAIT ON BIT STATE (WBS), 145
WRITE CMD LONG WORD (WCL), 174
WRITE CMD WORD (WCW), 175
Write Register, Immediate Type (WRI), 172
WRITE REGISTER, PROGRAM TYPE (WRP), 173

X

XOR, 122

Y

Year, 23

Z

ZERO TARGET & POSITION (ZTP), 182
ZERO TARGET (ZTG), 181